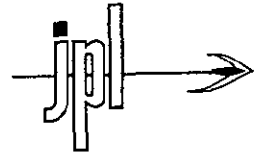


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**BATTERY LITERATURE SEARCH
BIBLIOGRAPHY AND ABSTRACTS**

July 1976

Volume I

Prepared by

The Boeing Company
P.O. Box 3999
Seattle, Washington 98124

For

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91103

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PREFACE

This comprehensive bibliography with abstracts, consisting of five volumes, was compiled to assist battery technologists to obtain information quickly on secondary aerospace battery cells and related technology. The subject index was extracted from The Battery Information Index prepared by the Battelle Memorial Institute, Columbus, Ohio, under Air Force Aero Propulsion Laboratory Contract No. AF33 (615)-3701. Index Citations B-1 through B-2189 (Vols. II through IV) were from the AFAPL sponsored work and includes references up to mid-1972. References TBC-3001 and on (Vol. V) were prepared by Boeing after reviewing computer searches from JPL's S.D.C. International Search Service, DDC, NTIS, Lockheed Information Retrieval Service, and Boeing Literature Search. References TBC-3301 and on cover the literature from 1972 to the end of 1975 and a few references prior to 1972 missed by the AFAPL work. Volume I consists of an extensive cross-referencing subject listing and an author index. An article covering several different subjects is referenced under each of the subject headings in the index. The index or author number refers to the referenced publications which are listed in a numerical sequence in Volumes II through V. Most citations contain an accession number which refers to the computer searches of the Defense Documentation Center, National Technical Information Service, etc. This number can be used to obtain a copy of the publication from the appropriate file source.

R. S. Bogner
Project Manager

ACKNOWLEDGEMENTS

This work was performed by D.D. Abbott and I.S. Mehdi, supervised by H. Ohman and approved by S.W. Silverman. JPL also wishes to acknowledge the cooperation of R. Marsh of AFAPL for supplying a large portion of the information used to compile this document.

CONTENTS

PREFACE	iii
ACKNOWLEDGEMENTS	iv
VOLUME I	
Subject Index	1-108
Author Index	109-146
VOLUME II	1-348
References B-1 thru B-899	
VOLUME III	
References B-900 thru B-1497	1-492
VOLUME IV	
References B-1500 thru B-2187	1-428
VOLUME V	1-171
References TBC-3001 thru TBC-3412	

Contents of the Bibliography

A comprehensive bibliography of references has been compiled dealing with nickel-cadmium cells and related technology for aerospace applications. The bibliography consists of a list of approximately 2400 articles, papers, test reports; and books with abstracts. An extensive subject listing is provided with cross-referencing with an author index in D180-18849-2, (Volume I). Both the subject index and author index list numbers after the subject or name of author and these numbers refer to the accession lists of D180-18849-2, Volumes II through V. The citations are accompanied by abstracts in most cases and also numbers which refer to computer searches of Defense Documentation Center, NTIS, etc.

The subject index was extracted from the Battery Information Index prepared by The Battelle Memorial Institute, Columbus, Ohio, under Air Force Aero Propulsion Laboratory Contract No. AF33(615)-3701. The index is not limited to nickel-cadmium battery technology only, but encompasses all batteries. This index can be used in the future to develop a bibliography for other types of batteries also. To support this index the citations referred to also have been included in Volumes II, III, and IV. (B-1 through B-2189). This list includes most of the citations up to the middle of 1972. Volume V lists (TBC-3001 and on) all the citations from mid 1972 up till the first quarter of 1975 and also picks up a few of the items prior to 1972 not in the AFAPL Battery Information Index.

Most of the present effort was expended in getting the most recent citations. The effort began with review of computer searches from JPL's S.D.C. International Search Service, DDC, NTIS, Lockheed Information Retrieval Service, and Boeing Literature Search. Technical Journals were also scanned and articles selected from them.

User's Guide

The method for using the bibliography is as follows:

If literature regarding a particular subject is required, the subject index is entered and the subject heading found. There will be some numbers listed in the bibliography in Volumes II-V. Locate these numbers in the list of citations and obtain information regarding titles, authors and abstracts. For further related literature, other articles or reports by these authors can be looked up through the author index. An example of how to go about locating the literature for a particular subject follows.

EXAMPLE: Suppose we would like to get information on flight data for batteries used on the Mariner Spacecraft. We would look up "Flight Data Mariner Spacecraft". A copy of page 32 of the subject index is shown in Exhibit 1 and the subject of interest is circled. There are three citations - Nos. 670, 1803, and 3146 listed. Now, by going to the list of citations in Vol. II - V we can get the titles, author, and abstract information related to these numbers. Exhibits 2, 3, and 4 are copies of these pages.

EXHIBIT-1A

Failure, internal short; 612, 632
Failure, lithium batteries, 2052
Failure, lithium-copper fluoride batteries, 988
Failure mechanisms, definition; 777, 1410
Failure mechanisms, nickel-cadmium cells; 1385, 1842, 2020, 3070
Failure mechanisms, nickel electrodes, 1871
Failure mechanisms, sealed cells; 1152, 1377, 3070
Failure models; 1173
Failure modes, analysis of converter; 790A
Failure modes, cadmium-air cells; 1334, 1339
Failure modes, cadmium-oxygen cells; 920
Failure modes, definition; 777, 1410
Failure modes, nickel-cadmium cells; 586, 908, 1294, 3008, 3020
Failure modes, nickel-zinc batteries; 2066
Failure modes, seals; 2106
Failure modes, separator material tests; 1658
Failure modes, silver-cadmium cells; 2194
Failure modes, silver-zinc cells; 968, 2067
Failure predictions; 803, 805
Failure predictions; methods; 1225, 2132, 2133
Failures, classification; 892
Failures, descriptions; 892
Failures, effects of environment; 1482
Feasibility studies; 880
Ferric oxide additions, cadmium electrodes; 2057
Fibrid separators; 1316
Field temperature effects; 605
Figure of merit, battery performance, 1087
Figure of merit, organic electrolytes; 1095
Filler materials, paste electrolytes; 1779
Films, cadmium hydroxide; 1376, 1970, 2054
Films, anisotropic characterization; 1707
Films, casting; 896
Films, formation on cadmium; 2040
Films, growth determination; 1346
Films, methanol treated; 966
Films, preparation for separators; 966, 1488, 1639, 1640, 1707
Filters, band pass; 588
Fischer analysis, organic solvents; 1075
Flame-spraying technique; 665
~~Flight data, Discoverer orbiting vehicle; 470~~
Flight data, Mariner spacecraft; 670, 1803, 3146
~~Flight data, OGO orbiting vehicle; 471, 472~~
Flight history, nickel-cadmium batteries, 20 ampere hour; 1527
Flight tests, CF-100 aircraft; 605
Float operation, elevated temperature; 1206
Flock fabrication; 1896, 1931
Flooded cells; 557, 630, 658
Flooded sealed cells; 701

B-670.

Charles W. Brooke, Jr., California Institute of Technology, Jet Propulsion Laboratory, "Development of an Electrochemical Energy Source for the Mariner II Spacecraft", NASA-CR-71772, JPL-TR-32-854 (March 15, 1966), Contract NAS 7-100. N66-22207. Abstract only.

The development of an electrochemical energy source for the Mariner II spacecraft is described. The data presented trace the development of this battery, beginning with the definition of the electrical and mechanical requirements for the battery and concluding with the telemetered data obtained from the battery during 109 days of spaceflight to Venus. The design changes resulting from the type approval test program on the development model battery and the additional changes dictated by the Mariner II spacecraft system requirements were combined in the final Ag-Zn battery design.

B-671.

R. Lutwack and G. M. Arcand, California Institute of Technology, Jet Propulsion Laboratory, "Energy Storage", NASA-CR-64605, Space Programs Sum. No. 37-33, Vol. IV, pp 47-48 (June 30, 1965). N65-32420. Abstract only.

Progress is reported on the development of a separator for the Ag-Zn battery that will be capable of withstanding heat sterilization. Analysis of test results showed that the material prepared from the low-density polyethylene by precross-linking with electron beam irradiation to the 70-megarad level followed by grafting with acrylic acid should be considered for more extensive testing. Also, experimental results are given for the measurement of the effects of γ -radiation on the behavior of nickel and cadmium electrodes in alkali media. Irradiated Cd electrodes lose more capacity than comparison electrodes. Also, there seems little doubt that maximum loss occurs when the electrodes are cycled about the 75%-of-charge point. Further, the data show that more material is lost from the Cd than from the Ni.

B-672.

Martin Sulkes, Yardney Electric Corporation, "Development of the Sealed Zinc-Silver Oxide Secondary Battery System", Report (1966). AD 635 776. Abstract only.

The reaction between Zn and O was investigated during overcharge and on stand. The electrolyte level and the type of separator used in cells were the most important factors in the reaction rate. Investigation of the $\text{AgO-Ag}_2\text{O}$ hydrogen reaction showed that the rate increased with temperature potential, the addition of Pd to the Ag, and the mobility of the electrolyte. Sealed Ag-Zn cells may be overdischarged at the C/4 rate without developing excessive pressure. Electrochemically inactive or nondischargeable Zn reacts with the O generated during reversal. Physical, chemical, and electrical properties are presented for many separator and interseparator materials. Several inorganic separator materials were evaluated. Evaluation cycling and cycle life data were obtained for 244 sealed Ag-Zn cells.

B-673.

R. S. Bogner, General Motors Corporation, "Heat-Sterilizable Silver-Zinc Battery Investigation", Final Report, NASA-CR-63597 (March 15, 1965), Jet Propulsion Laboratory Contract JPL 950364 under Prime Contract NAS 7-100. N65-27367. Abstract only.

B-1802

A. Caiola, H. Guy, and J.C. Sohm, Ecole Nationale Supérieure d'Electrochimie et d'Electrometallurgie de Grenoble, "Prospects of Research in the Field of Storage Batteries", Entropie, (26), 57-65 (March-April 1969).

In an aprotic organic solvent, it is possible to use very reducing metals (e.g., lithium) in a secondary battery. The use of a metal oxide at the positive electrode is no more possible as it was the case in aqueous systems. A thermodynamic study shows the metal oxide can be replaced by a copper salt and it confirms the choice of lithium as negative electrode. A systematic study is done to select the solvents which are suitable; this study can be lead by some experimental rules about the length of the hydrocarbon chain, the function, the presence of cycles and so on. The experimental results exhibit that it is possible to make a rechargeable second kind lithium electrode. A screening study of different anions which form the lithium salts is carried out.

B-1803

Card 1/2

NASA Jet Propulsion Laboratory, "Space Programs Summary 37-61. Vol. 1, Flight Projects", November 1 to December 31, 1969 (January 31, 1970), NASA Contract NAS 7-100. N70-26079.

I. Mariner Mars 1969 Project

A. Project Description and Status

B. Guidance and Control

1. Post-Encounter Performance of Mariner VI Spacecraft Battery
2. Mariner Mars 1969 Power Subsystem
 - a. Mariner VII Pre-Encounter Anomals
 - b. Extended Mission Support

Table 1. Battery Testing Sequence

Figure 1. Mariner VI Battery Current and Voltage Versus Time Test Sequence

Figure 2. Mariner VI Battery Current, Voltage, and Temperature Versus Time for First Post-Encounter Maneuver

Figure 3. Mariner VI Battery Charge Current Versus Time After First Post-Encounter Maneuver

Figure 4. Mariner VI Battery Current, Voltage, and Temperature Versus Time for Second Post-Encounter Maneuver

The test was performed on 180 sealed cells. The test program demonstrated that temperature is the most important factor affecting cell behavior. Cell operation is good at minus 10 C and + 10 C at any d.o.d. considered, while at + 30 C operation is generally bad. With a few exceptions, cells undergoing the cycling still work after about 440 cycles.

TBC-3145

David A. Aikens and Howard Littman, Rensselaer Polytechnic Institute, "Electrochemical Power Sources," Final Technical Report ECOM-69-0063-F, September 18, 1968 to January 31, 1974, Contract DAAB07-69-C-0063 (September 1974).

The report summarizes research in the areas of electrodes and electrolytes and heat and mass transfer in porous media. Heats of solution were determined for alkali metal salts in nitrile solvents and the structure of electrolytes - nitrile solutions has been studied by Raman spectroscopy and conductance. Data on non-aqueous electrolytes has been compiled. Properties of reference electrodes and liquid junctions in propylene carbonate have been studied potentiometrically and the problem of uncompensated resistance has been studied by electrostatic methods. The effect of cycling on sealed Ni-Cd batteries has been studied. Liquid-gas distribution in porous media has been studied by modeling techniques and by gamma scattering. The coupling of thermal and mass transport with electrochemical processes at the three phase interface has been studied using a microelectrode, and theoretical studies of evaporation from thin films have been performed.

TBC-3146

R. S. Bogner, Jet Propulsion Laboratory, "Mariner Mars 1971 Battery Design, Test, and Flight Performance," Report No. NASA-CR-132986, (JPL-TM-33-591), Contract NAS 7-100 (April 15, 1973) p. 194.

The design, integration, fabrication, test results, and flight performance of the battery system for the Mariner Mars spacecraft launched in May 1971 are presented. The battery consists of 26 20-Ah hermetically sealed nickel-cadmium cells housed in a machined magnesium chassis. The battery package weighs 29.5en1 kg and is unique in that the chassis also serves as part of the spacecraft structure. Active thermal control is accomplished by louvers mounted to the battery baseplate. Battery charge is accomplished by C/10 and C/30 constant current chargers. The switch from the high-rate to low-rate charge is automatic, based on terminal voltage. Additional control is possible by ground command or onboard computer. The performance data from the flight battery is compared to the data from various battery tests in the laboratory. Flight battery data was predictable based on ground test data.

SUBJECT INDEX TO BATTERY ABSTRACTS

1

A

Absorbers, performance; 663, 888, 1901
Absorbers, stability; 662, 866
Absorbers, spectra, iron chloride in organic solvents; 1319
Accelerated life tests, charged wet stand; 769A
Accelerated life tests, definition of ideal test; 1377
Accelerated life tests, empirical approaches; 1152, 3237, 3343
Accelerated life tests, nickel-cadmium batteries; 1627, 2007, 2131, 3011, 3069, 3070, 3089
Accelerated life tests, physical approaches; 1152, 3237, 3343
Accelerated life tests, statistical approaches; 1152, 3237, 3343
Accelerated life tests, temperature stress factor; 1220, 3237
Accelerated life tests, theoretical; 1152, 1173, 3237
Accelerated testing, aerospace batteries; 1800, 3043, 3237
Accelerated testing, communications equipment; 892
Accelerated testing, lead-calcium batteries; 1206
Accelerated testing, nickel-cadmium cells; 921, 1225, 1574, 1747, 2132, 2133, 3237, 3361
Accelerated testing, separators; 2106
Accelerated testing, silver-zinc cells; 1141
Acceleration tests; 1053
Accelerated thermal cycling, nickel-cadmium cells; 2128
Acceptance tests, auxiliary electrodes; 488, 654, 706, 1150, 2071
Acceptance tests, coulometer controlled; 701
Acceptance tests, neoprene seals; 639
Acceptance tests, nickel-cadmium cells; 620, 683, 710, 784, 890, 917, 1149, 1554, 1573, 1624, 1650, 1681, 1736, 1758, 1841, 1941, 1951, 1952, 2000, 2071, 2095, 2137, 2138, 2139
Acceptance tests, Plitt seals; 507
Acceptance tests, requirements; 1624
Acceptance tests, storage methods; 1497
Acceptance tests, silver-zinc cells; 1555, 1626, 1749, 2059
Acetamide solvents, properties; 1231
Acetamide solvents, purification; 1231
Acetate additions, electrodes, nickel-cadmium cells; 355, 360
Acetic Anhydride solvents; 1011
Acetonitrile, acid-base equilibria; 1266
Acetonitrile, chromatographic analyses; 983, 995, 1023
Acetonitrile-dimethyl cyanamide mixed solvents; 1091
Acetonitrile-hexafluorophosphate electrolytes; 946, 947, 971, 973
Acetonitrile-propionitrile solvents; 1212
Acetonitrile solvents, properties; 967, 971, 1024, 1091, 1212, 1261, 1266, 1295
Acetonitrile solvents, purification; 971
Acetonitrile solvents, voltage stability; 1604
Acetonitrile, transference numbers; 1024

Acetyl chloride electrolytes; 1914
Activated stand life, silver-zinc cells; 1467
Activation devices; 423, 465, 588, 627
Activation devices, automatic; 464, 465
Activation energy, diffusion of hydrogen in nickel hydroxide; 629
Activation energy, diffusion of sulfate ions; 880
Activation energy, hydrogen evolution on lead; 1063
Activation time tests; 595
Active material loading, cadmium electrodes; 1696
Activity coefficients, alkali metal halides; 1312
Activity coefficients, lithium chloride in dimethyl sulfoxides; 1112, 1383
Activity coefficients, measurement, effect of heat transfer; 1383
Additions (See specific element or compound)
Adhesion, lithium materials to grids; 925
Adhesives, mercury-cadmium cells; 1817
Adhesives, nickel-cadmium batteries; 559
Adhesives, thermosetting; 729
Advent communication satellite, batteries; 433
Agena space vehicle; 432
Aging, sealed batteries; 1627, 2020
Air depolarized cells; 2061
Air electrodes, acids; 887
Air electrodes, alkalis; 887
Air electrodes, bubbling, operation; 1143
Air electrodes, carbonate effects; 887
Air electrodes, characteristics; 1355
Air electrodes, evaluation; 837, 2144
Air electrodes, limitations; 1355
Air electrodes, organics; 2143
Air electrodes, poisoning by soluble cadmium; 1334, 1339
Air electrodes, selection and testing; 1264
Air entrapment; 3159
Air primary cells, dry; 4, 7, 64
Air primary cells, wet; 4, 10
Aircraft batteries, construction; 1618
Aircraft batteries, evaluation; 3179
Aircraft batteries, hydrogen/oxygen; 2146
Aircraft batteries, lead-acid; 605, 1813
Aircraft batteries, limitations; 1618
Aircraft batteries, nickel-cadmium; 605, 682, 914, 1622, 1623, 1813, 1995
Aircraft batteries, silver-cadmium; 421, 1429
Aircraft batteries, survey; 506, 1514
Aircraft batteries, vented, capacity-voltage behavior; 1579
Aircraft batteries, vented, service life; 632
Aircraft batteries, vented, temperature range; 682
Aircraft electric systems, battery study; 1621
Aircrew survival transceiver batteries; 1540
Alginate-honeycomb fabrication; 1896
Alkali hydroxide solutions, physico-chemical properties; 1594
Alkaline batteries; 3293
Alkaline batteries, forecast; 2089, 3085

Alkaline cells, primary and secondary, engineering data; 1179
Alkaline electrolyte, chlorate-borate-acetate; 1592
Alkaline primary cells, dry; 4, 10, 404
Alloy electrodes, lead-acid batteries; 1959
Alloy electrodes, passivation studies; 356
Alternating current impedance measurements, nickel-cadmium cells; 1548, 1549
Alternating current superimposed on charging; 724
Alternators, space power application; 1662
Altitude tents; 595
Aluminosilicate separators, sintered; 964
Aluminum additions, nickel electrodes; 1982
Aluminum additions, zinc electrodes; 1202B
Aluminum-air cells, low discharge efficiencies; 1355
Aluminum alloy electrodes; 1887
Aluminum cell cases; 1209, 1308
Aluminum cell cases, organic electrolyte systems; 1208
Aluminum chloride chemistry; 933
Aluminum chloride, coordination complexes, organic solvents; 1389
Aluminum chloride electrolyte; 1599
Aluminum chloride eutectic melts; 1283, 1671
Aluminum chloride, purification; 1359, 1643
Aluminum chloride, solubility in organic solvents; 1389
Aluminum chloride solutes; 1008
Aluminum chloride solutions, decomposition; 1001
Aluminum chlorine batteries, rechargeable; 1642, 1910
Aluminum chlorine cells; 1283, 1359, 1442, 1578, 1642, 1643, 1671
Aluminum-copper batteries, patents; 1814
Aluminum dry cells; 7
Aluminum dry cells, patents; 1814
Aluminum electrodes, chloride melts; 1283, 1910
Aluminum electrodes, dendrite formation; 1442, 1578, 1642, 1671
Aluminum electrodes, dry tape batteries; 1072
Aluminum electrodes, molten salt electrolytes; 1445
Aluminum electrodes, organic electrolytes; 1445
Aluminum electrodes, passivation; 1442, 1578, 1671, 1910
Aluminum fluoride electrodes, organic electrolytes; 1103
Aluminum hydroxide additions, alkaline electrolytes; 327
Aluminum-nickel chloride cells; 1036
Aluminum nitrate solutions; 1983
Aluminum oxide additions, alkaline electrolytes; 651
Aluminum-polynitrile cells, patents; 1814
Aluminum reserve electrodes; 356
Aluminum-sodium-potassium chloride phase diagram; 1642
Aluminum thin film batteries, patents; 1814
Amalgam electrodes, alkaline solutions; 2075
Amalgam electrodes, dimethyl formamide solutions; 1466
Amalgam electrodes, propylene carbonate solutions; 1466
Amalgamated metal surfaces; 624
Amalgamation experiments, silver-zinc cells; 583

Amide solvents, polarography; 1314
Amide solvents, properties; 1231, 1314, 1490
Amide solvents, purification; 1231, 1314
Amide solvents, selection of reference electrodes; 1314
Amine electrolyte batteries, design; 3196
Amine electrolytes; 1375
Amines, tertiary, electrodes; 2002
Aminoethylene-mercuric oxide dry cells, patents; 1814
Ammonia batteries, low temperature operation; 1053, 1105, 1657
Ammonia batteries, patents; 1814
Ammonia electrodes; 1189
Ammonia oxidation, nickel-cadmium cells; 1934
Ammonia primary reserve cells; 3, , 64
Ammonia solvents, properties; 1233
Ammonia solvents, purification; 1233
Ammonium carbonate additions, nickel electrodes; 602
Ammonium chloride additions, zinc powder; 1484
Ammonium hydroxide solutes; 1268
Ampere hour meters; 883
Amplifier, operational, RCA monolithic; 628
Amplifier, power supplies; 650, 827
Analysis procedure, nickel-cadmium cells; 3372
Analyzers, battery performance; 339
Analyzers, multichannel, data acquisition; 289
Analyzers, pulse; 377
Analyzers, vibration; 588
Anodic dissolution, metals, 1003, 3366
Anodic films, silver electrodes; 554
Anodic oxidation, cadmium electrodes; 903, 3262
Anodic oxidation, cadmium in potassium carbonate; 1857, 3238
Anodic oxidation, silver electrodes; 1684, 2111, 2173
Anodic passivation, reactive metals; 241
Anodization of nickel foil; 1545
Antimony additions, cadmium electrodes; 2183, 3248
Antimony additions, alkaline electrolytes; 327
Antimony additions, lead electrodes; 1811, 2069
Antimony additions, silver oxide samples; 1593
Antimony migration, separators; 1705
Apollo program requirements; 376, 382, 387
Apollo telescope mount batteries, 2041, 3142, 3240
Appliances, battery-powered; 1876
Applications, commercial; 1514
Applications, typical nickel-cadmium cells; 910
Aqueous battery systems, patents; 1814
Arsenic additions, alkaline electrolytes; 327, 1304
Arsenic additions, cadmium electrodes; 1061
Arsenic additions, lead electrodes; 1959
Arsenic additions, silver oxide samples; 1593
Arsenic-cerium fluoride cells, patents; 1814
Astronomical Observatory, orbiting vehicle batteries; 30, 3024, 3029

Asymmetric, alternating current; 627
Atmosphere explorer orbiting vehicle batteries; 621, 631, 678, 970
Audio frequency impedance; 198
Auger analysis; 3195
Automotive batteries; 900
Autoradiography methods, battery application; 1756
Auxiliary electrodes, current signal; 307, 359
Auxiliary electrodes, effects of position; 359, 375, 508
Auxiliary electrodes, fuel cell type; 306, 434, 508, 619, 762, 1701, 1932
Auxiliary electrodes, hydrogen consuming; 253, 310, 434, 539, 598, 634, 654
Auxiliary electrodes, instrumentation; 512, 634, 654
Auxiliary electrodes, nickel-cadmium cells; 160, 193, 202, 204, 249, 253, 310
326, 334, 355, 448, 488, 539, 619, 655, 682, 691, 706, 762, 811, 859,
909, 1108, 1197, 1258, 1333, 1379, 1515, 1816, 1952, 2096, 2137, 2138,
2178, 3037, 3039, 3040, 3109, 3110, 3119
Auxiliary electrodes, nickel-zinc cells; 2066
Auxiliary electrodes, passive; 202, 698
Auxiliary electrodes, reviews; 101, 877
Auxiliary electrodes, silver-cadmium cells; 304, 674, 2096
Auxiliary electrodes, silver-zinc cells; 376, 674, 807
Auxiliary electrodes, temperature effects; 169, 355, 375, 664, 691, 1151
Auxiliary electrodes, VCB Black; 334, 359, 697
Auxiliary electrodes, voltage signals; 90, 169, 359, 375, 500, 530, 558, 1151,
1933
Azodicarbonamide organic depolarizer; 1964

B

Ball milling techniques; 572
Balloon batteries, low temperature; 1282, 1440, 1557
Balloon battery design; 1287
Barium additions, nickel electrodes, 200, 201, 1966
Barium-air cells, low discharge efficiencies; 1355
Barium, properties in organic solvents; 1232
Battery analog; 3191
Battery model; 3200, 3273
Battery, primary; 1505
Beacon batteries; 1540
Beacon/transceiver applications; 1901
Benzofuroxan, electroreduction in organics; 2143
Benzoic acid, filler for pressed cadmium electrodes; 1511
Benzonitrile solvents, voltage stability; 1604
Beryllium alloy electrodes; 849
Beryllium organic complexes, preparation; 935, 1001
Beryllium organic complexes, solutes; 933, 934
Beta-alumina, utilization in electrochemical systems; 1946
Bibliography, battery technology; 1430, 3108
Bibliography, components; 1430
Bibliography, non-aqueous batteries; 1092, 1094
Bibliography, spacecraft batteries, 965, 1430
Bibliography, thermal properties; 1637

Binders, carboxymethylcellulose; 1925
Binders, Cellulosic; 837
Binders, compatibility tests, organic electrolytes; 973
Binders, fluorocarbon; 3346
Binders, fugitive; 553, 565
Binders, negative plate, amalgamation experiments; 583
Binders, nickel fluoride electrodes; 973
Binders, plastic; 602
Binders, polyethylene; 1925
Binders, polyisobutylene; 2123
Binders, polystyrene; 3300
Binders, polytetrafluoroethylene; 312, 365, 515
Binders, polyvinyl alcohol; 502
Binders, sodium carrageenan; 1791
Binders, teflon; 1509
Bipolar electrodes, evaluation, silver-zinc cells; 886, 1721, 1722
Bipolar electrodes, fabrication; 1525, 2082
Bipolar electrodes, fabrication, magnesium cells; 1506
Bipolar electrodes, fabrication, nickel-cadmium cells; 729, 802
Bipolar electrodes, fabrication, silver-zinc cells; 207, 313, 423, 790, 1474
Bipolar electrodes, formation, nickel-cadmium cells; 771
Bipolar electrodes, pulse discharge; 802
Bipolar electrodes, utilization, nickel-cadmium cells; 1934
Bis-dimethylaminosulfoxide solvents; 1926
Bismuth additions, alkaline electrolytes; 919
Bismuth additions, silver oxide samples; 1593
Biurea, organic depolarizer; 1964
Bobbin cell design; 1657
Boiling points, organic solvents; 1184
Borate additions, alkaline electrolytes; 1407, 1592
Boron trifluoride additions, organic electrolytes; 1238
Boron trifluoride reserve cells; 7
Bromide salt additions, alkaline electrolytes; 83
Bromine Electrodes, organic electrolytes; 1403, 1902
Bromine-zinc secondary cells; 773
Butyrolactone-aluminum chloride electrolytes; 1161
Butyrolactone, chromatographic analysis; 995
Butyrolactone, compatibility with cell components; 1129
Butyrolactone-dimethylformamide solvents; 1185
Butyrolactone-dimethoxyethane electrolyte; 1746
Butyrolactone, electrolysis, properties; 1107
Butyrolactone-hexafluorophosphate electrolytes; 941, 973, 1031, 1209
Butyrolactone-hexafluorophosphate electrolytes, properties; 1129
Butyrolactone-lithium chloride electrolytes; 957
Butyrolactone-lithium fluorotrate electrolytes; 332, 961
Butyrolactone-lithium tetrafluoroborate electrolytes, conductivity effects of temperature; 111d
Butyrolactone-perchlorate electrolytes; 1095
Butyrolactone solvents; 936, 938, 939, 962, 1188, 1190, 2043, 2108, 2112
Butyrolactone solvents, bibliography; 956

C

Cadmium additions, alkaline electrolytes; 161, 1304, 1680
Cadmium additions, nickel electrodes; 81, 108, 177, 199, 860, 3249
Cadmium additions, silver oxide samples; 1593
Cadmium-air cells, components; 887, 3392
Cadmium-air cells, performance characteristics; 879, 1339, 1355, 2025, 2103, 3392
Cadmium-air cells, weight analysis; 1176
Cadmium amalgam electrodes, studies; 2075, 3338
Cadmium-cadmium coulometer; 1475
Cadmium carbonate, formation; 19, 3115, 3356
Cadmium chloride electrodes in formamide; 1373
Cadmium chloride electrodes, organic electrolytes; 1519, 1950
Cadmium chloride electrodes, organic solvents; 1586
Cadmium chloride, heat or reaction with formamide; 1373
Cadmium chloride, solubility in formamide; 1939
Cadmium chloride, standard potential in formamide; 1373
Cadmium concentration, plates; 647
Cadmium content in electrodes; 1776
Cadmium crystals, growth retardation; 893, 3384
Cadmium data; 3292, 3327, 3331, 3333, 3335, 3345, 3349, 3351
Cadmium dendrites, alkaline cells; 1830, 2024
Cadmium distribution, plates; 647
Cadmium, electrochemical behavior; 81, 287, 294, 455, 1970, 2054, 3327, 3338
Cadmium electrodes, absorption of hydrogen and oxygen; 81
Cadmium electrodes, activation; 1537
Cadmium electrodes, additives; 2057, 3295
Cadmium electrodes, aging; 527
Cadmium electrodes, amalgamated; 1204
Cadmium electrodes, anodic dissolution in alkaline solutions; 1970, 3362
Cadmium electrodes, anodic dissolution in nitrate solutions; 739
Cadmium electrodes, cadmium/cadmium hydroxide ratio; 447
Cadmium electrodes, carbonate contamination; 1412
Cadmium electrodes, characterization; 1412, 3132, 3297, 3348
Cadmium electrodes, charge-discharge characteristics; 179, 772, 1202D, 1418, 3366, 3378, 3400, 1419, 1697, 1895, 3297, 3353, 3363, 3367, 3368, 3371
Cadmium electrodes, chemical analysis; 1776, 2131, 3132
Cadmium electrodes, corrugated foil; 1945
Cadmium electrodes, crystal size; 760, 3365
Cadmium electrodes, current distribution models; 1195, 1697, 1895, 3387
Cadmium electrodes, cycling behavior; 697, 820, 2088, 2131, 3378
Cadmium electrodes, design; 285, 336
Cadmium electrodes, drying process; 896
Cadmium electrodes, effect of carbonate; 1873
Cadmium electrodes, effects of foreign ions; 327
Cadmium electrodes, effects of thickness on cell capacity; 1252
Cadmium electrodes, electrical characteristics; 1334, 1418, 3050
Cadmium electrodes, electrochemical behavior; 2119, 3283, 3297, 3330, 3366
Cadmium electrodes, electrochemical reduction; 81, 287, 294
Cadmium electrodes, electrodeposited; 2065, 3114
Cadmium electrodes, evaluation; 199, 277, 510, 887, 1176, 3050

Cadmium electrodes, expanders; 2057
Cadmium electrodes, extenders; 2057
Cadmium electrodes, fabric base, preparation; 1891
Cadmium electrodes, ferric oxide additions; 2057
Cadmium electrodes, fibrous, preparation; 775
Cadmium electrodes, formation cycling; 440
Cadmium electrodes, galvanostatic pulse measurements; 2054
Cadmium electrodes, heavy (0.085 in.); 1067
Cadmium electrodes, high capacity; 920, 1890
Cadmium electrodes, high porosity; 894, 1575
Cadmium electrodes, hydrogen-free capacity; 454
Cadmium electrodes, impedance characteristics; 2009
Cadmium electrodes, impedance measurements; 2054
Cadmium electrodes, impregnation data; 1457
Cadmium electrodes, impregnation techniques; 718, 802, 1696, 1890, 3210
Cadmium electrodes, indium additions; 2057
Cadmium electrodes, irradiation effects; 671
Cadmium electrodes, kinetics, low temperature; 648, 761
Cadmium electrodes, loading effects; 633, 3282
Cadmium electrodes, loss of active material; 438, 1612
Cadmium electrodes, loss of capacity; 1843, 2090, 2131
Cadmium electrodes, metallographic studies; 903
Cadmium electrodes, micro fuel cells; 783, 889
Cadmium electrodes, microscopic observations; 1698
Cadmium electrodes, morphological changes; 1568, 1698, 1853, 2090, 3185, 3186
Cadmium electrodes, non-magnetic; 1837
Cadmium electrodes, organic electrolytes; 492, 981, 982, 1022, 1321
Cadmium electrodes, passivation; 903, 1175, 1568, 1915, 3112, 3362, 3366
Cadmium electrodes, pasted; 618, 1334, 1339, 1608, 2063
Cadmium electrodes, perchlorate electrolytes; 1560
Cadmium electrodes, physical characteristics; 1172, 2077, 2119
Cadmium electrodes, polarization; 540
Cadmium electrodes, porosity; 894, 919, 3282, 3400-3401, 3402
Cadmium electrodes, potential, oscillographic measurements; 319
Cadmium electrodes, preparation; 5, 82, 84, 85, 103, 110, 113, 114, 133, 143, 153, 155, 157, 191, 220, 256, 258, 294, 296, 302, 304, 332, 361, 438, 601, 665, 718, 719, 815, 863, 873, 911, 920, 1110, 1340, 1343, 1352, 1377, 1402, 1409, 1479, 1507, 1537, 1620, 1696, 1812, 1828, 1888, 1937, 1956, 1969, 1999, 2004, 2018, 2077, 2088, 2091, 2119, 2160, 2170, 2181, 2183, 3028, 3050, 3121, 3140, 3210, 3230, 3306, 3315, 3320
Cadmium electrodes, preparation, fused salt; 1889
Cadmium electrodes, pressed; 704, 722, 1441, 1511, 1609, 2141
Cadmium electrodes, radiation effects; 1611, 1612
Cadmium electrodes, reaction mechanism; 13, 14, 169, 244, 245, 903, 3348, 3352, 3355, 3357, 3368, 3369
Cadmium electrodes, a single-pore; 3176, 1339
Cadmium electrodes, sponge; 199, 815, 1334, 1339, 1343, 2057
Cadmium electrodes, standard potential in formamide; 1939
Cadmium electrodes, state-of-the-art; 1334, 1339
Cadmium electrodes, state-of-charge; 447, 908
Cadmium electrodes, support material studies; 438, 1451, 1476, 2088

Cadmium electrodes, supported; 199, 3312
Cadmium electrodes, teflonated; 1837, 2077, 3113, 3114, 3119
Cadmium electrodes, utilization of active materials; 1412, 2131
Cadmium electrodes, weight analysis; 879
Cadmium electrodes, weight decrease; 821
Cadmium electrodes, weight increase; 1343
Cadmium electrodes, X-ray diffraction studies, 540, 2183, 3353
Cadmium fluoride electrodes, preparation; 1209, 3051
Cadmium grids; 515, 583
Cadmium hydroxide, electrolytic deposition; 1888
Cadmium hydroxide, formation; 244, 1175, 3316, 3334, 3335, 3336, 3341, 3352, 3353, 3354, 3355, 3365, 3367, 3368, 3369, 3370, 3371, 3378, 3405
Cadmium hydroxide, reduction; 3355
Cadmium hydroxide, solubility; 3326, 3359, 3356
Cadmium ions; 3356
Cadmium, inactive; 2021
Cadmium-lead dioxide reserve cells; 7, 10
Cadmium-magnetite electrodes; 610
Cadmium-manganese batteries, patents; 1814
Cadmium-mercuric oxide primary button cells; 797, 2141
Cadmium-mercuric oxide secondary cells; 7
Cadmium migration, cadmium electrodes; 903, 1199, 3392, 3404
Cadmium migration; 2003, 3057, 3067, 3123, 3403
Cadmium oxidation; 81, 179, 244, 287, 294, 340, 346, 455, 2040, 3355
Cadmium oxide additions, zinc electrodes; 238, 408
Cadmium oxide characterization; 3295, 3296, 3299, 3308, 3332, 3340, 3350, 3360
cadmium oxide electrodes, preparation; 423, 3224
Cadmium oxide, heat of formation; 323
Cadmium oxide, hydration; 272, 617
Cadmium oxide powder, surface area measurements; 272
Cadmium oxide, precipitation; 560
Cadmium oxide reduction; 3276, 3364
Cadmium-oxygen cells, activation; 1343
Cadmium-oxygen cells, components; 1343
Cadmium-oxygen cells, design; 1251
Cadmium-oxygen cells, development; 280, 920, 1067, 1343
Cadmium-oxygen cells, performance data; 920
Cadmium-oxygen cells, rechargeable; 1067
Cadmium-oxygen recombination reaction; 613, 1598
Cadmium penetration through separators; 1334, 1339, 3066
Cadmium precipitates, alkaline solutions; 1654
Cadmium systems, organic electrolytes; 1305
Calcium additions, silver oxide samples; 1593
Calcium-air cells, low discharge efficiencies; 1355
Calcium chloride-zinc chloride dry primary cells; 4
Calcium electrodes, organic electrolytes; 943, 947, 1030, 1091, 2121, 1223, 1305
Calcium hydroxide additions, zinc electrodes; 751, 1406
Calcium hydroxide film separators; 1353
Calcium hydroxide film separators, effects of quality; 1109
Calcium hydroxide film separators, electrodeposited; 1109
Calcium hydroxide film separators, presence of electrolyte in pores; 1109

Calcium hydroxide film separators, silver-cadmium cells; 496
Calcium-lead grids; 7, 69, 885
Calcium-nickel cells, patents; 1814
Calcium, properties in organic solvents; 1232
Calcium, reaction with organic solvents; 1107
Calcium-silver cells, patents; 1814
Calcium-silver chloride cells; 1212
Calcium-silver chloride cells, patents; 1814
Calcium, stability in organic electrolytes containing sulfur; 1111
Calculation, bond strengths; 2087
Calorimeters; 530, 548, 550, 644, 650, 688, 757, 867, 883
Calorimeters, calibration studies; 688, 867
Calorimeters, design; 867, 1136, 1780, 1869, 2107
Calorimeters, operating conditions; 1285
Calorimetry, half-cell entropy changes; 550
Calorimetry, lithium-copper fluoride cells; 986, 990
Calorimetry, lithium-silver chloride cells; 937, 940
Calorimetry, nickel-cadmium cells; 11, 196, 323, 449, 530, 558, 650, 688, 867, 1108, 1254, 1285, 1301, 1428, 2093
Calorimetry, nickel-cadmium cells, bibliography; 1136
Calorimetry, separators; 2106
Calorimetry, silver-zinc cells; 196, 464, 1337, 1468
Capacitance, silver halide film formation; 1911
Capacity, calculation; 798
Capacity, cell, matching; 272
Capacity data, cadmium electrodes; 294, 610, 1853, 3028
Capacity data, lead-acid cells; 605, 1860
Capacity data, nickel-cadmium cells; 53, 333, 358, 507, 577, 585, 605, 606, 652, 717, 1622, 1682, 1683, 3125
Capacity data, nickel electrodes; 730, 1871, 3383
Capacity data, silver-cadmium cells; 652, 1441, 3125
Capacity data, silver electrodes; 753
Capacity data, silver-zinc cells; 652
Capacity, effects of float charge; 612
Capacity, effects of periodic current; 1144, 1145, 1146
Capacity, effects of temperature; 912
Capacity, electrodes; 10, 193, 211, 212, 348, 400, 492, 513, 521, 645, 3028
Capacity, electrodes, calculation; 540, 798, 799, 3253, 3254
Capacity, electrodes, effects of swelling; 838
Capacity, fading; 102, 104, 130
Capacity, fading, nickel hydroxide electrodes; 2019
Capacity, function of discharge rate, magnesium-manganese dioxide dry cells; 1371
Capacity, function of storage time; 798
Capacity, function of temperature; 798
Capacity, function of temperature, magnesium-manganese dioxide dry cells; 137
Capacity increase due to heat sterilization; 734
Capacity increase, nickel electrodes; 557, 1058
Capacity increase, silver electrodes; 1677

Capacity loss, cadmium electrodes; 1334, 1339, 1698, 1853
Capacity loss due to heat sterilization; 441, 888, 1051, 1300, 1369, 1636
Capacity loss due to irradiation; 239, 671
Capacity loss, effects of pH gradients; 1199
Capacity loss, mercury cells, effects of storage temperature; 1737
Capacity loss, nickel-cadmium cells; 140, 910, 1257, 1656, 3403
Capacity loss, nickel electrodes; 1257
Capacity loss, reduction; 527, 2156
Capacity loss, silver electrodes; 725, 1293, 1636
Capacity loss, silver-zinc cells; 338, 452
Capacity loss, silver-zinc cells, low temperature storage; 1806
Capacity loss on stand; 737
Capacity loss per year; 846
Capacity loss, zinc electrodes; 1636
Capacity, nickel electrodes; 1695, 3096
Capacity ratio, nickel-cadmium cell electrodes; 1402
Capacity, recovery; 648, 963, 2153
Capacity, residual; 584
Capacity, residual, positive electrodes; 730
Capacity retention during storage; 1371
Capacity test measurement techniques; 541, 1101
Capacity tests; 541
Capacity versus storage time and temperature, sealed silver secondary cells;
1582
Capillaries, hollow; 2048
Capillary fed electrolytes; 842
Capillary shielding; 780
Carbon additions, copper fluoride electrodes; 1793
Carbon additions, silver electrodes; 898
Carbon content, electrodes, organic cells; 1081
Carbon electrodes, active for chlorine reduction; 1587, 1671
Carbon electrodes, composite, preparation; 773
Carbon electrodes, dry tape batteries; 1291
Carbon electrodes, high surface area; 1425
Carbon electrodes, stability; 1359
Carbon electrodes, stability in electrolytes; 1442, 1671
Carbon-platinum electrodes; 598
Carbon-tungsten composite electrodes, performance; 1425
Carbon-zinc primary cells, dry; 69, 166, 885
Carbonate contamination, electrolytes; 1859, 1873, 3067
Carbonate effects, battery plate cycling; 1607, 1608
Carbonate effects, cell behavior; 19, 327, 513, 557, 733, 896, 908, 1334,
1339, 1873, 1956, 3363, 3392, 3404
Carbonate effects, vented nickel-cadmium batteries; 1579
Carbonate effects, zincate trapping; 751
Carbonate formation, alkaline battery electrolytes; 1410, 3115
Carbonate removal, thermal cracking; 1412
Carbonate solutions, controlled; 906, 3356
Carbonyl-dimidazole solutions, electroreduction; 1908

Carbonyl nickel powder, characterization; 1416
Carbonyl nickel power plaques, preparation; 703, 1416
Carbonyl nickel power, properties; 611, 1635
Carbonyl nickel power, sintered; 1635
Carbowax additions, electrodes, nickel-cadmium cells; 426
Cardiac pacemaker, mercury or alkaline manganese dioxide batteries; 1514
Case construction, aluminum; 2109
Case, construction drawing; 1581
Case construction, fiberglass; 1574, 1645
Case construction, plastic; 1785, 1941, 2046
Case construction, plurality cell connection; 1825
Case construction techniques; 1290, 3001
Case construction, tests; 1801, 3143
Case, remountable cell; 1581, 1800
Case failure; 1336
Case material selection; 662, 806, 1290, 1812
Cathodic precipitation; 1469
Cathodization experiments, organic electrolytes; 1003
Cell configuration options; 1648
Cell manufacturing equipment and materials; 1649
Cell manufacturing procedures; 1455
Cell matching criteria; 1512
Cell opener, construction drawing; 1370, 1538
Cellulose additions, electrolytes; 77, 231, 232, 518
Cellulose oxidation; 1547
Cellulose separators; 451, 503, 580, 587, 1712, 1714
Cellulose separators, permeation by zinc; 897
Centaur launch vehicle batteries; 482, 561
Center of gravity changes, silver-zinc batteries; 1468
Cesium additions, potassium hydroxide electrolytes; 336, 360, 370, 430, 510, 1901
Cesium halides, solubility in organic solvents; 1228
Cesium hydroxide electrolytes; 1282, 1812
Cesium hydroxide electrolytes, density; 1616
Cesium, properties in organic solvents; 1232
Charge acceptance, cadmium electrodes, effects of temperature; 760
Charge acceptance, lead-acid batteries; 2028
Charge acceptance, nickel electrodes; 1594, 1871
Charge acceptance, sterilized cells; 1299
Charge acceptance, tension and torsion effects; 1380
Charge capacity, cadmium electrodes; 294
Charge capacity, nickel electrodes; 247, 1893
Charge capacity, silver electrodes; 324
Charge conditioners; 393, 430, 497
Charge control; 1470
Charge control, batteries; 1622
Charge control, bibliography; 501
Charge control, bipolar nickel-cadmium cells; 1525
Charge control by cell reversal; 774
Charge control devices; 202, 326, 388, 420, 625, 630, 631, 634, 697, 698, 699, 706, 714, 719, 762, 859, 865, 909, 1453, 1475, 1816, 1823, 1824, 1858, 1933, 2116

Charge control electrodes; 193, 619, 634, 664, 697, 698, 706, 719, 756,
762, 829, 259, 865, 909, 1067, 1099, 1513, 1817, 1818, 1951, 1967,
2041

Charge control evaluation; 202, 698

Charge control methods; 193, 202, 309, 355, 360, 420, 497, 501, 642, 649,
698, 756, 774, 806, 811, 1932, 3162, 3239

Charge control solid state; 202, 628, 963

Charge control systems, current-sensing; 1938

Charge control systems, nickel-cadmium cells, 248, 355, 586, 642, 649, 682
1198, 1453, 1524, 1595, 1744, 1971, 2003, 3059, 3027, 3057, 3162, 3234, 3373, 3377

Charge control systems, silver-cadmium cells; 1453

Charge control systems, silver-zinc cells; 625, 767, 1453

Charge control temperature sensor; 1822

Charge controller design; 1554

Charge-discharge characteristics, lithium electrodes; 1586

Charge-discharge characteristics, lithium-cupross chloride cells; 1877

Charge-discharge characteristics, silver-zinc cells; 2134

Charge-discharge conditioning procedures; 1337, 3059

Charge-discharge controllers; 644, 883, 1932, 2003, 3234

Charge-discharge efficiencies; 576, 578, 3232

Charge-discharge parameters; 1440

Charge-discharge reactions, lead-acid batteries; 1766

Charge-discharge reactions, sintered nickel; 1856

Charge-discharge, superpositioned curve sets; 803

Charge-discharge test circuits, automatic; 870

Charge efficiency, cadmium electrodes; 454, 648, 760, 793

Charge efficiency, lithium-nickel fluoride cells; 971

Charge efficiency, nickel-cadmium cells; 2, 89, 193, 332, 529, 558, 633, 1513, 3156

Charge efficiency, nickel electrodes; 727

Charge efficiency, silver-cadmium cells; 193, 645, 723

Charge efficiency, silver-zinc cells; 193, 583

Charge mechanisms, nickel electrodes; 552, 629

Charge-porosity; 3400, 3401

Charge redistribution, electrodes, effects of pH gradients; 1199

Charge regulators, spacecraft batteries; 390, 461

Charge retention, lithium-copper chloride cells; 1278

Charge retention, lithium-copper fluoride cells; 1015

Charge retention, nickel-cadmium cells; 24, 121, 360, 370, 407, 475, 544, 578

Charge retention, zinc batteries; 2064

Charge retention, organic electrode systems; 1223

Charge retention, secondary cells; 1178, 3201

Charge retention, silver-zinc cells, effect of temperature and storage time; 1866

Charge transfer reactions, cadmium electrodes in perchlorate electrolytes; 1560

Charge transfer resistance; 2148

Charge transport studies; 796, 3015

Charge voltage measurements, silver-zinc cells; 1725

Charging characteristics, copper chloride electrodes; 2011

Charging characteristics, nickel-cadmium cells; 649, 1525, 1777, 2178

Charging characteristics, primary cells; 1944

Charging characteristics, silver-cadmium cells; 1429
Charging circuits; 69, 774, 1197, 1933
Charging conditions, effects on electrodes; 725
Charging, constant potential; 531, 549, 628, 1656
Charging, current, effects of magnitude; 648
Charging, current, monitoring method, 1938
Charging, current reversals; 753, 1677
Charging curves, nickel-cadmium cells; 1548, 1549, 1550
Charging devices; 603, 885, 3002
Charging devices, diminishing rate; 524
Charging devices, review; 2029, 3002
Charging efficiency, nickel-cadmium cells; 1407, 1589, 3377
Charging, heat sterilized nickel-cadmium cells; 919
Charging methods, Kordes-Marko bridge; 2031
Charging methods, resistance-free voltage measurements; 2031
Charging methods, theory and practice; 1179, 1995, 2061, 3002
Charging modes, nickel-cadmium cells; 2106
Charging, periodic currents (See Charging, pulsed current)
Charging procedures, nickel-cadmium cells; 401, 545, 586, 910, 2164
Charging procedures, silver-zinc cells; 621, 627, 804, 1099, 2008, 2184
Charging processes, review; 2028
Charging, pulsed current, apparatus; 865, 1822, 3106
Charging, pulsed current, computer-controlled; 2032
Charging, pulsed current, nickel-cadmium cells; 45, 403, 1513, 1821, 2030, 3007, 3271, 3384
Charging, pulsed current, silver electrodes; 1144, 1145, 1146
Charging, pulsed current, silver-zinc cells; 756, 1930, 2125
Charging, pulsed current, zinc electrodes; 747, 768, 865, 3007
Charging, rapid; 1821, 1822, 1944, 3047, 3048, 3049
Charging, rate regulation, nickel-cadmium cells; 1619
Charging rates, effects, nickel-cadmium cells; 41, 578, 1726, 1842, 3091
Charging rates, effects, nickel electrodes; 200, 475
Charging rates, effects, silver-zinc cells; 515, 1252, 1726
Charging rates, variation; 606
Charging, reverse polarity, nickel-cadmium cells; 483, 774
Charging system, satellite battery; 1512, 1748
Charging times, 70 and 90 F with C/15 charge rate; 1804
Charging times, silver electrodes; 2174
Charging, trickle, nickel-cadmium cells; 441, 544, 1777, 2136
Charging voltages, lithium-silver chloride cells; 1118
Charging voltages, nickel-cadmium cells; 403, 1498
Chelation studies, silver-cadmium cells; 646
Chemical analysis, nickel-cadmium cells; 16, 3152, 3372, 3409, 3411, 3412
Chemical reactions, lead-acid cells; 470
Chemical reactions, Leclanche' cells; 479
Chemical reactions, nickel-cadmium cells; 12, 246, 467, 479, 640, 3036
Chloranil electrodes, positive; 1943
Chloride contamination, nickel-cadmium cells; 1956
Chloride electrodes, reversible; 1778
Chloride salt additions, electrolytes; 83, 1357, 1981

Chloride solutes, 925, 930, 932, 967, 1131, 1329
Chloride solutes, purification; 1295
Chloride ternary melt, conductivity; 1643
Chlorides, electrodes for high temperature batteries; 1076
Chlorides, mixed, eutectic melts; 1283
Chloride absorption, charcoal; 1084, 1237
Chlorine depolarized primary reserve cells; 3
Chlorine electrodes, chloride melts; 1283, 1671
Chlorine electrodes, organic electrolytes; 1902
Chlorine electrodes, performance; 1005
Chlorine electrodes, polarization; 1004, 1018, 1034, 1082, 1083, 1237
Chlorine electrodes, preparation; 1904
Chlorine gas, analysis; 1005
Chlorine, reaction with propylene carbonate; 1107
Chlorine reduction, carbon electrodes; 1359, 1442, 1910
Chlorine storage; 1923
Chloro-copper complex formation; 1244, 1269
2-chloroethanol solvents; 1329
Chloromethyl carbonate electrolyte; 1774
Chromate contamination, nickel-cadmium cells; 1956
Chromatography, analyses of organic solvents; 983, 984, 995, 1019, 1023,
1132, 1154, 1288
Chromic oxide electrodes, organic electrolytes; 1016
Chromium electrodes, organic electrolytes; 982, 1305
Chromium fluoride electrodes, preparation; 1313
Chromium oxide electrodes, polarization; 1133
Chromium reserve electrodes; 356
Chronopotentiometry, organic electrolytes; 881, 933, 935, 962, 967, 1291
Chronopotentiometry, organic electrolytes, reproducibility; 1019
Classification, battery types; 582
Coating apparatus modifications; 709
Coatings, electroplating; 1891
Coatings, inorganic, electrodeposited; 1717
Cobalt additions, alkaline electrolyte; 1304
Cobalt additions, cadmium electrodes; 527, 1537
Cobalt additions, nickel-cadmium cell performance; 1758, 3398
Cobalt additions, nickel electrodes; 60, 200, 201, 270, 447, 475, 577, 585,
587, 606, 640, 810, 919, 1059, 1140, 1257, 1364, 1455, 1922, 2154, 2155, 3286, 3398
Cobalt additions, silver oxide samples; 1593
Cobalt chloride electrodes, organic electrolytes; 980
Cobalt, effect on nickel electrode; 1469
Cobalt electrodes, organic electrolytes; 979, 980, 1001
Cobalt, electroless; 3188
Cobalt fluoride electrodes, organic electrolytes; 936, 938, 939, 941, 986, 1103
Cobalt fluoride electrodes, polarization; 992
Cobalt fluoride electrodes, preparation; 1313
Cobalt fluoride electrodes, voltammetry tests; 990
Cobalt fluoride electrodes, X-ray examination; 1002

Cobalt fluoride, solubility in organic solvents; 1002
Cobalt hydroxide, solubility in potassium hydroxide; 1741
Cobalt hydroxide, solubility in sodium hydroxide; 1741
Cobalt nitrate additions, nickel plates; 1607, 1608
Cobalt oxidation in potassium hydroxide; 2040
Cobalt oxide electrodes, organic electrolytes; 979
Cobalt oxides; 3188, 3189, 3190
Cobalt systems, organic electrolytes, 1305
Coefficients of expansion, cell materials; 1468
Communication equipment batteries; 879, 1573, 1641, 1832
Compatibility, cells, with complete power systems; 369, 393
Compatibility, materials for molten salt organic cells; 1779
Compatibility, materials for organic batteries; 973, 991, 992, 1094, 1095
1184, 1313
Compatibility, metal grids in organic electrolyt; 1534
Complex formation, non-aqueous; 1604
Complex ions, organic electrolyte; 1556
Component analysis, degradation processes; 1385
Component reliability; 586, 790A
Component weight analysis, metal-air cells; 820, 881
Component weight analysis, silver-zinc cells; 790
Components, dimensions, weights, zinc-oxygen cells; 1663
Components, properties after sterilization; 1256
Components, reliability, nickel-cadmium batteries; 1539
Components, thickness data, nickel-zinc cells; 1665
Composite film separators; 690, 1751
Composite membranes, fabrication; 1398
Composite separator systems, physical properties; 1399
Compression, cell assemblies; 784, 908
Compression studies, nickel-cadmium cell components; 784, 1299, 1378
Computer control, anodic oxidation reactions; 2177
Computer programs, battery data analyses; 466, 803, 805, 1195, 2032, 3029
Computer programs, calorimetric data processing; 1301
Computer programs, combinatorial frequencies; 728
Computer programs, dynamic performance; 2034
Computer programs, pulse charging; 3198
Computer programs, satellite electric power systems; 2068
Computer programs, surface area calculations of battery materials; 526, 3164
Computer programs, thermal analyses; 461, 462, 579
Concentration gradients, zincate ions; 1796
Concentration overpotential, reduction; 780
Conditioning, nickel-cadmium cells; 541, 708
Conductance coefficients, calculation; 2135
Conductance, electrolyte systems, lithium batteries; 1795
Conductivity, aqueous electrolytes; 1130
Conductivity, electrolytes for silver-zinc celling; 1365
Conductivity, electrolytic, of alkali metal hydroxides; 1148
Conductivity, fused salts; 1839
Conductivity, organic electrolytes; 643, 924, 925, 926, 927, 928, 939, 941,
942, 943, 944, 945, 946, 947, 948, 950, 978, 979, 980, 981, 982, 983,
984, 985, 986, 990, 1000, 1020, 1023, 1029, 1036, 1081, 1086, 1091,
1103, 1104, 1120, 1130, 1184, 1223, 1245, 1313, 1600

Conductivity, organic electrolytes containing aluminum chloride; 1161, 1389
Conductivity, organic electrolytes containing sulfur; 1111
Conductivity, organic solvents; 1075, 1212
Conductivity, organic sulfur solvents; 1236
Constant current, charging; 45, 202, 347, 388, 458, 485, 500, 531, 554, 1677, 2096, 3146
Constant current, limited voltage systems; 698, 2096
Constant voltage, charging; 45, 202, 249, 458, 485, 540
Constant voltage, coulometer systems; 698
Container design; 111, 173, 283, 385, 417, 478, 490, 600, 1894
Container development; 788
Container fabrication; 693
Container, fiberglass; 616
Container, injection moldable materials; 884
Container materials; 663, 1785
Container, spill-proof; 1894
Container testing; 597, 1785
Control amplifiers; 650
Control cells, special design; 909, 3074, 3075, 3076, 3116
Control circuits, automatic, battery powered; 799
Control consoles; 588
Control electrodes, nickel-cadmium cells, sealed; 844, 1379, 1629
Conversion efficiency, nickel-cadmium systems; 649
Converter-battery study; 1474, 1722, 1723, 1724
Converter performance; 790A
Converter starting circuit problems; 790A
Converter synchronization; 732A
Cooling devices, nickel-cadmium batteries; 1990, 2079, 2097
Cooling devices, silver-zinc batteries; 573
Coordination complexes, aluminum chloride with lithium chloride; 1161
Copper additions, alkaline electrolytes; 1304
Copper additions, nickel electrodes; 140, 1058
Copper chloride; 1599
Copper chloride electrodes; 871, 930, 932, 958, 961, 980, 1022, 1047, 1103, 1159, 1244, 1269, 1321
Copper chloride electrodes, composition; 1177
Copper chloride electrodes, cycling behavior; 1003
Copper chloride electrodes, discharge rates; 1280
Copper chloride electrodes, fabrication; 961
Copper chloride electrodes, high temperature batteries; 1077, 1078
Copper chloride electrodes, kinetics in propylene carbonate; 1156, 2011
Copper chloride electrodes; kinetics in triethylene glycol; 2011
Copper chloride electrodes, organic electrolytes; 1386, 1774
Copper chloride electrodes, performance; 1278
Copper chloride electrodes, polarization; 1159, 1187, 2011
Copper chloride electrodes, preparation; 928, 938
Copper chloride electrodes, thin; 1309
Copper chloride electrodes, utilization; 1043
Copper chloride, separators for; 1850
Copper chloride, solubility in butyrolacrone; 1041

Copper chloride, solubility in organic electrolytes; 931, 932, 958, 961, 1047, 1049, 1160, 1180, 1269, 1278, 1377
Copper chloride, solubility in propylene carbonate; 1244
Copper concentration, organic electrolytes; 1043
Copper contamination, nickel-cadmium cells; 1956
Copper-copper sulfate half-cells; 550
Copper-cyanide systems, calorimetric studies, 548
Copper dendrites, formation; 1793
Copper electrodes, organic electrolytes; 492, 978, 979, 980, 981, 1001, 1321
Copper electrodes, voltammetric tests; 492
Copper fluoride, analyses; 987, 1073
Copper fluoride, dehydration; 987
Copper fluoride, electrodeposition; 991, 994
Copper fluoride electrodes; 930, 932, 939, 948, 955, 979, 980, 986, 1000, 1022, 1091, 1103, 1321, 1328
Copper fluoride electrodes, additions of other metal fluorides; 1014
Copper fluoride electrodes, analysis; 988
Copper fluoride electrodes, analysis of discharge products, 1088
Copper fluoride electrodes, charge retention; 1245
Copper fluoride electrodes, doped, 1014
Copper fluoride electrodes, dry tape batteries; 1217
Copper fluoride electrodes, effects of discharge rate; 1329
Copper fluoride electrodes, effects of particle size; 1245
Copper fluoride electrodes, efficiency; 944, 1015, 1073, 1088, 1104, 1792
Copper fluoride electrodes, fabrication; 944, 959, 960, 1032
Copper fluoride electrodes, kinetic studies; 1313
Copper fluoride electrodes, organic solvents; 1586
Copper fluoride electrodes, passivation; 1088
Copper fluoride electrodes, polarization; 931, 992, 993, 1129, 1186, 1311, 1886
Copper fluoride electrodes, preparation; 928, 938, 987, 989, 1015, 1021, 1086, 1227, 1308, 1311, 1313, 1329, 1483
Copper fluoride electrodes, preparation from hydrated copper fluoride; 1014
Copper fluoride electrodes, reduction mechanisms; 1288, 1954
Copper fluoride electrodes, utilization; 927, 929, 936, 941, 953, 989, 1019, 1021, 1086, 1210
Copper fluoride electrodes, voltammetry tests; 990
Copper fluoride electrodes, water content; 988
Copper fluoride electrodes, X-ray examination; 994, 1002
Copper fluoride, methods of sintering; 991
Copper fluoride, preparation from basic copper carbonate; 959
Copper fluoride, solubility in butyrolactone; 1073, 1106
Copper fluoride, solubility in lithium fluoride; 1793
Copper fluoride, solubility in organic electrolytes, 959, 960, 967, 987, 1002, 1015, 1047, 1086, 1155, 1160, 1180, 1186, 1241, 1245, 1311, 1313, 1329, 1483, 1886
Copper fluoride, solubility in propylene carbonate; 1014, 1106, 1155, 1238
Copper fluoride, ultra pure, preparation techniques; 1405
Copper fluoride, X-ray diffraction examination; 1106
Copper halide electrodes, polarization; 1327

Copper migration, organic batteries; 1309
Copper oxide electrodes, high temperature batteries; 1077
Copper oxide electrodes, organic electrolytes; 492, 978, 979, 981
Copper reference electrodes, hydrogen fluoride; 1097
Copper-silver alloy electrodes; 807
Copper, solubility in propylene carbonate; 1126
Copper sulfide electrodes; 1659
Copper sulfide electrodes, organic electrolytes; 991, 1103, 1239, 1351, 1386
Copper systems, organic electrolytes; 1305
Copper ;thiocyanate electrodes; 1659, 1755
Core assemblies, cells, compression studies; 784, 830
Corrosion, iron-nickel alloys; 594
Corrosion, nickel electrodes; 445, 557, 3383
Corrosion, nickel plaques; 1507
Corrosion, steel parts, nickel-cadmium batteries; 3272
Corrosion, substrate materials; 1469
Corrugated foil electrodes; 1896, 3068, 3204, 3205
Costs, cadmium-air cells; 2103
Costs, comparison, batteries; 10, 64, 65, 66, 211, 605, 1286, 1335
Costs, nickel-cadmium cells; 16, 24, 71
Costs, operation, batteries; 605
Costs, sales data, lithium batteries; 1033
Coulogravimetric studies, zinc electrodes; 519
Coulometers; 87, 202, 326, 336, 355, 360, 630, 682, 1475, 1596, 1991, 1992, 2096
Coulometers, cadmium; 1515, 1622, 1816, 1823
Coulometers, charge control; 658, 701, 883, 909, 1197, 1470, 1655, 3013
Coulometric analyzers; 715
Coulometric charging; 326, 360
Coulometric efficiency, electrode materials in organic electrolytes; 928
Coulometric efficiency, lithium-chlorine cells; 1083
Coulometry, m-dinitrobenzene; 1693
Crosslinking, polymers; 868, 1639, 1640
Cryptanalysis, battery data; 728
Crystallographic changes, during discharge; 1668
Crystallography, nickel oxide; 475, 479
Crystallography, silver electrodes; 1678
Cupric chloride electrode; 961
Cupric chloride electrodes, fabrication; 961
Cupric chloride electrodes, polarization; 1797
Cupric chloride electrodes, thermal stability; 1797
Cupric fluoride dihydrate; 959
Cupric fluoride dihydrate electrolytes; 960
Cupric fluoride hydrate; 1927
Cupric fluoride-sulfur electrodes, fabrication; 1755
Cupric sulfide electrodes, organic electrolytes; 1775
Cupric sulfide electrodes, preparation; 2185
Cuprous bromide, electronic conduction; 1566
Cuprous chloride, electronic conduction; 1566
Current, controlled, electrochemical methods; 1558
Current densities, high, nickel-cadmium cells; 802

Current densities, limiting, rectangular channels; 1563
Current densities, silver-zinc cells; 725
Current distribution experiments; 692, 780, 824, 1376, 3009, 3257, 3373
Current distribution, pores, 1288, 1780
Current distribution; 780, 3257, 3258, 3277
Current efficiency, mathematical analysis; 1087
Current interrupter design; 1079
Current interrupter techniques; 685, 770, 1080
Current limiters; 202, 277, 388, 512
Current limiting resistors; 524
Current measurement techniques; 1401, 2124
Current, peak, tests; 595
Current pulse, measurement techniques; 1101, 1481
Current recorders; 715
Current reversal; 856
Current reversal, periodic; 747
Current sensors; 631, 714
Current variation, experimental results; 549
Cyanide anion additions, zinc electrodes, 1830
Cycle life data, silver-zinc cells; 1806
Cyclic life, effect of design variables; 1459, 3019
Cycle life tests, maximum, nickel-cadmium cells; 1629, 3084
Cycle life tests, measurement techniques; 1101
Cyclic carbonate solvents, biolliography; 956
Cyclic carbonates; 956
Cyclic current-step apparatus; 1298
Cyclic current-step measurements; 1421
Cyclic esters, analysis by gas chromatographic techniques; 1450
Cyclic voltammetry, electroless cobalt; 3188
Cyclic voltammetry, cuprous chloride; 1877
Cyclic voltammetry, electrode screening; 492, 1505
Cyclic voltammetry, lithium; 1877, 2045
Cyclic voltammetry, m-dinitrobenzene; 1693
Cyclic voltammetry, silver chloride; 1877
Cycling control; 1195
Cycling facility; 708
Cycling devices; 1748
Cycling, high rate; 576
Cycling, high temperature; 727
Cycling, prolonged; 95, 431, 1459
Cycling tests, accelerated by temperature; 607, 626
Cycling tests, apparatus; 339, 520, 650, 706, 844, 889, 942
Cycling tests, cadmium-oxygen cells; 1067
Cycling tests, lead acid cells, positive plates; 1345
Cycling tests, lithium batteries; 1599, 2052, 2053
Cycling tests, lithium-copper fluoride cells; 989
Cycling tests, lithium-nickel chloride cells; 926
Cycling tests, lithium-nickel fluoride cells; 971, 975
Cycling tests, lithium-silver chloride cells; 940, 942, 951, 952, 2111

Cycling tests, lithium-silver fluoride cells; 1031
Cycling tests, mercury-cadmium cells; 1557
Cycling tests, nickel-cadmium cells; 8, 30, 35, 102, 104, 189, 190, 193, 199, 203, 206, 243, 272, 277, 391, 394, 441, 539, 540, 541, 544, 558, 604, 655, 716, 800, 806, 1378, 1379, 1384, 1385, 1454, 1458, 1513, 1631, 1644, 1807, 2128, 3014
Cycling tests, nickel-zinc cells; 596, 1486, 1880, 2064, 2066
Cycling tests, non-aqueous batteries; 1003
Cycling tests, regimes, 530, 652, 681, 769A, 844, 900, 908, 1069
Cycling tests, secondary batteries; 1, 7, 10, 64, 65, 66, 101
Cycling tests, silver-cadmium cells; 8, 189, 190, 193, 199, 203, 206, 272, 304, 604, 645, 1068, 1418, 1441, 1582
Cycling tests, silver-zinc cells; 189, 190, 193, 206, 208, 210, 231, 237, 238, 330, 338, 365, 408, 450, 581, 604, 672, 750, 1289, 1302, 1337, 1363, 1390, 1406, 1486, 1582, 1749, 1801, 1838, 2134
Cycling tests, spacecraft batteries; 1367
Cycling tests, zinc-air systems; 538
Cycling tests, zinc-oxygen cells; 694, 1057, 1296, 1297, 1663
Cycling, vacuum, nickel-cadmium cells; 613

D

Data acquisition systems; 663, 908, 951, 1095, 1195, 1225, 1381
Data analysis, computerized; 1292, 1364, 1384
Data analysis, nickel-cadmium cells; 805, 3090, 3398
Data requirements and formats; 1294
d.c. to d.c. converter design; 732A, 790A, 886, 886A, 1474
d.c. to d.c. converter performance; 886A, 1721, 1722, 1723
d.c. to d.c. converter surge current, initial, control; 886A
Decay processes, nickel-cadmium cells; 556
Decomposition potentials, organic electrolytes; 927, 931, 942, 952, 1074, 1085, 1092, 1094, 1095, 1104
Decomposition potentials, organic solvents; 1086, 1096, 1261
Deferred-action batteries, design; 2120
Degradation rate, definition; 1152
Density, organic solvents; 1075
Density variations, electrodes, silver-zinc cells, 1468
Depolarizers, thermal batteries, 881
Design factors; 1662, 3085, 3091
Deterministic statistics; 1528
Deuterated nickel electrodes; 552
Dichloroisocyanuric acid electrodes; 1217, 1262, 1291, 1914
Didymium hydroxide additions, nickel hydroxide; 650
Didymium nitrate additions, nickel plates; 1607, 1608
Dielectric constant, inorganic liquids; 1235
Dielectric constant measurement apparatus; 1667
Dielectric constant, organic solvents; 1184
Dielectric properties, ammonium chloride; 1487

Dielectric properties, electrolytes; 1162, 1487, 1667, 1808
Dielectric properties, electrolytes and batteries; 918
Dielectric properties, organic solvents; 1584
Dielectric properties, potassium hydroxide; 1487, 1667, 1784
Dielectric properties, sodium hydroxide; 1487
Dielectric strength tests, 595
Diethyl sulfite solvents; 1186
Diethylene glycol dimethyl ether electrolytes; 1885
Differential capacitance; 3187
Differential thermal analysis, cadmium electrodes; 1630
Differential thermal analysis, nickel electrodes, 444, 1257, 1630, 2093
Diffraction techniques, battery application; 1756
Diffusion coefficient, acetonitriles; 1562
Diffusion coefficient, chlorine; 1923
Diffusion coefficient, chloride ion; 2102
Diffusion coefficient, dimethyl formamide; 1562
Diffusion coefficient, hydrogen; 629
Diffusion coefficient, lithium ions; 1782
Diffusion coefficient, methyl formate; 1562
Diffusion coefficient, nickel electrode; 1559, 3015
Diffusion coefficient, oxygen; 1234, 3035, 3388
Diffusion coefficient, propylene carbonate; 1562, 1781
Diffusion coefficient, silver ions; 1466
Diffusion coefficient, sulfate ions; 880, 881
Diffusion coefficient, zincate ions; 632, 1200, 1486, 1796, 1883
Diffusion coefficients in organic electrolytes; 967
Diffusion currents, nickel hydroxide; 1559
Diffusion equation using Green's functions; 782C
Diffusivity in membranes; 749
Diffusivity, molecular; 3148
Dimethyl carbonate perchlorate electrolytes; 1086
Dimethylacetamide solvents, properties, 1231, 1852
Dimethylacetamide solvents, purification; 1231
Dimethyldioxane solvents, 1168
Dimethylformamide, chromatographic analyses; 983, 995
Dimethylformamide-lithium chloride electrolytes; 932, 967
Dimethylformamide solvents; 936, 1091, 1295, 1312, 1795
Dimethylformamide solvents, properties, 1024, 1231
Dimethylformamide solvents, purification; 1231
Dimethylformamide solvents, solubility; 1778, 1852
Dimethylformamide solvents, voltage stability; 1604
Dimethylformamide, thiocyanates in; 1743
Dimethylformamide, transference numbers; 1023
Dimethyloxyethane solvents, voltage stability; 1604
Dimethylsulfite perchlorate electrolytes; 1086, 1090
Dimethylsulfite solvents; 1181, 1728, 1926, 1946, 2039
Dimethylsulfite-trifluoromethane-sulfonate electrolytes; 1181
Dimethyl sulfone; 1542, 1742
Dimethylsulfoxide, electrochemical studies, review; 1009
Dimethylsulfoxide, heat of solution; 1489
Dimethylsulfoxide hexafluorophosphate electrolytes; 938, 973, 1063

Dimethylsulfoxide-lithium bromide electrolytes; 954
Dimethylsulfoxide-lithium bromide electrolytes, thermodynamics; 1415
Dimethylsulfoxide-lithium chloride electrolytes, thermodynamic properties, 1112
Dimethylsulfoxide-lithium iodide electrolytes; 1492
Dimethylsulfoxide-morpholinium hexafluorophosphate electrolytes; 975
Dimethylsulfoxide-phenyltrimethylammonium hexafluorophosphate electrolytes, 975
Dimethylsulfoxide, properties, review; 1009
Dimethylsulfoxide solvents; 955, 1276, 1415, 1606, 1953
Dimethylsulfoxide solvents, conductance, 1279
Dimethylsulfoxide solvents, density; 1279
Dimethylsulfoxide solvents, double layer capacities; 1127
Dimethylsulfoxide solvents, electrocapillarity curves; 1127
Dimethylsulfoxide solvents, properties, 971, 1112, 1279, 1852
Dimethylsulfoxide solvents, purification; 971
Dimethylsulfoxide solvents, solubility; 1279, 1778
Dimethylsulfoxide solvents, viscosity; 1279
Dimethylsulfoxide solvents, voltage stability; 1604
Dimethylsulfoxide tetramethylammonium hexafluorophosphate electrolytes; 975
Dimethylsulfoxide-tetramethylammonium tetrafluoroborate electrolytes; 975
2-4 dinitroaniline electrodes, properties; 1276
m-dinitrobenzene, electrochemical reduction; 1693
Dinitrobenzene electrodes, non-aqueous electrolytes; 1189
Dinitrobenzene electrodes, organic electrolytes, 928, 1757
Dinitrobenzene, particle size, effects on cell performance; 1071
Diodes, charge control; 186, 187, 188, 311, 326, 337, 366, 483, 524, 963
1062, 1453, 1725, 1726
Diodes, current blocking; 524
Diodes, protection against current reversal; 856, 1062
Disadvantages, silver-zinc cells; 627
Discharge apparatus, high current, low voltage; 802
Discharge capacities, nickel-cadmium cells, effects of sealants; 1137
Discharge capacities, nickel-cadmium cells, low temperature; 442
Discharge capacities, silver electrodes; 1688, 2172
Discharge capacities, silver-zinc cells, effects of heat sterilization; 2193
Discharge characteristics, equations; 31, 328, 799
Discharge characteristics, iron electrodes; 1879
Discharge characteristics, lead-acid batteries; 2101
Discharge characteristics, nickel-cadmium cells; 1498, 1656, 3059
Discharge characteristics, silver-cadmium cells; 1429
Discharge-charge circuits; 889
Discharge, complete, nickel-cadmium cells; 95
Discharge conditioning, effects on zinc electrodes; 695
Discharge conditioning, nickel-cadmium cells; 383
Discharge control devices; 814
Discharge control, nickel-cadmium cells, 203
Discharge, deep, nickel-cadmium cells; 102, 135
Discharge, deep, silver-zinc cells; 450
Discharge depth, effects on nickel-cadmium cells; 277, 309, 800, 1644, 2131
Discharge depth, effects on performance, 1842

Discharge depth, lead-acid cells, positive plates; 1945
Discharge high rate, bipolar cells; 771
Discharge, high rate, terminal design; 1564
Discharge measurement techniques; 1101
Discharge mechanisms, cadmium electrodes; 13, 14, 244, 245, 1697, 1895
Discharge mechanisms, nickel electrodes; 629, 1509, 3261
Discharge mechanisms, zinc electrodes; 245
Discharge performance, lead-acid cells; 31
Discharge performance, lithium-copper fluoride cells; 1210
Discharge performance, lithium-silver sulfide cells; 1787
Discharge performance, nickel-cadmium cells; 2, 9, 11, 24, 31, 53, 81, 101, 121, 193, 544, 912, 3019
Discharge performance, nickel-zinc cells; 1880
Discharge performance, silver-cadmium cells; 193, 723
Discharge performance, silver-zinc cells; 193, 208, 276, 561, 627
Discharge performance, transition metal sulfides; 1366
Discharge, pulse, bipolar plates; 802
Discharge, random, tests, nickel-cadmium cells; 540
Discharge rates, effects on cadmium electrodes; 760
Discharge rates, effects on nickel-cadmium cells; 53, 771, 1384, 3069, 3070
Discharge, self, lithium-chlorine cells; 1084
Discharge, self, lithium-copper chloride cells; 1182
Discharge, self, negatives; 3344
Discharge, self, nickel-cadmium cells; 53, 130, 302, 333, 358, 392, 1513, 1966
Discharge, self, silver-zinc cells; 350
Discharge, shallow, nickel-cadmium cells; 67, 277
Discharging characteristics, nickel-cadmium cells; 1525, 1777, 3172
Discoverer orbiting vehicles, flight data; 470
Discoverer orbiting vehicle, temperature histories; 470
Disilver trioxide; 1730
Disodium fluorescein, additions to propylene carbonate; 2113
Dissection, cells; 970
Dissolution, cadmium in neutral electrolytes; 739
Dissolution, copper fluoride, 1792, 1793, 1954
Dissolution, magnesium in perchlorate; 2140
Dissolution mechanism, cadmium in potassium hydroxide; 1568, 1970
Dissolution-precipitation mechanism; 3317, 3337, 3339, 3355, 3366, 3369, 3371
Dissolution-precipitation mechanism, cadmium in potassium hydroxide; 1854
Dissolution rate measurement; 1605
Dissolution, zinc in mercury; 707
Dissolution, zinc in potassium nitrate; 744
Dissolution, zinc oxide in potassium hydroxide; 632, 745, 866, 1796
Double grids; 238, 408
Double layer capacitance, amide solvents; 1490
Double layer capacitance, nickel electrodes; 46, 98, 198, 377, 3138, 3166
Double layer capacitance, porous electrodes; 1580
Double layer capacitance, silver electrodes; 459, 794, 1222
Double layer capacitance, zinc electrodes; 1194
Double layer capacitance, organic electrolytes; 1127
Double layer capacitance, lithium electrodes; 1569
Double plateau; 3410

Dry batteries, forecast; 2089
Dry batteries, specifications; 913
Dry cells, rechargeable, 1964
Dry tape batteries, 101, 705, 995, 996, 997, 998, 999, 1217,
Dry tape batteries, design; 1072, 1291
Dry tape batteries, encapsulation; 1291
Dry tape batteries, state-of-the-art; 1522
Dry tape batteries, testing apparatus; 998
Drying, wet formed plates; 850
Dummy cells; 662
Dyes, state-of-charge indicators; 1548, 1549

E

Edison cells (See Nickel-iron secondary cells)
Efficiencies, ampere hour, nickel-cadmium cells; 1219, 1809
Efficiencies, increased, sterilized nickel-cadmium cells; 1299
Efficiencies, theoretical, nickel-cadmium cells; 912
Elastomeric pressure relief devices; 720
Electric vehicles, battery systems, 260, 487, 1214, 1215, 1216, 1315, 2061,
2101
Electric vehicles, hybrid battery systems, 1514
Electric vehicles, hybrid power suppliers; 1215, 3255
Electric vehicles, lithium batteries, 1214, 1216, 1514, 1690, 1691
Electric vehicles, lithium-sulfur cells, 2092
Electric vehicles, nickel-cadmium cells; 1514
Electric wrist watch batteries; 159
Electric characteristics, nickel-cadmium cells; 46, 89, 98, 544, 691
Electric analysis, satellite subsystem, 2068
Electrical characteristics, nickel-cadmium electrodes; 1525
Electrical characteristics, zinc-oxygen cells; 1138
Electrical conductivities, potassium hydroxide; 865
Electrical double layer, non-aqueous solutions; 1501
Electrical interchangeability; 1703
Electrical leakage test techniques, 1101
Electrical resistance, indium contacts; 1408
Electrical resistance, membranes, 537, 661, 737
Electrical resistance, nickel-cadmium cells; 607
Electrical systems, aircraft/batteries; 1995
Electrocapillarity curves, organic electrolytes; 1127
Electrocatalyst screening tests; 879
Electrochemical cleaning technique; 1980
Electrochemical constants, theoretical, metal halide-lithium couples, 1519
Electrochemical kinetics, transient methods; 1605
Electrochemical power systems; 1662, 3093
Electrochemical reaction kinetics; 3325
Electrochemical reduction of nickel salt; 1695
Electrochemical research, educational requirements; 796
Electrochemical techniques, review; 1604, 3374, 3376, 3397

Electrochemistry, solid electrodes; 1598, 3036
Electrode couples, thermodynamics; 796
Electrode cycling tests, apparatus; 2171
Electrode geometry, effect on performance; 1292, 1576
Electrode grids, organic electrolytes; 1554
Electrode kinetics, cell systems; 796, 1788
Electrode kinetics, use of a.c. impedance measurements; 1156
Electrode materials, dry tape aqueous batteries; 997, 1217
Electrode materials, dry tape batteries, 995, 996, 997, 998, 999, 1217
Electrode materials, high temperature batteries; 1078
Electrode materials, organic electrolytes; 1001, 1038, 1074, 1081, 1085, 1351, 2053
Electrode materials, organic electrolytes review; 1087
Electrode materials, screening in organic electrolytes; 927, 928, 1505, 2043
Electrode materials, stability in organic electrolytes; 991, 992, 993, 994
Electrode materials, theoretical study of novel systems; 1315
Electrode matrix, 181, 353
Electrode, matrix, metal honeycomb; 571, 575
Electrode-organic electrolyte couples, screening; 1022
Electrode performance, effects of gas bubble formation; 1226
Electrode performance, effects of gravity; 1141
Electrode plaques, preparation; 2165
Electrode potentials, acetone, 1103
Electrode potentials, acetonitrile; 1266
Electrode potentials, formamide 1372, 1373
Electrode potentials, high energy density couples; 1130
Electrode potentials, liquid ammonia; 1233
Electrode potentials, methyl formate 1104
Electrode potentials, non-aqueous electrolytes; 1103
Electrode potentials, organic electrolytes; 1036, 1382
Electrode potentials, organic solvents, 1229
Electrode potentials, propylene carbonate; 1104
Electrode potentials, screening at 0 C; 1503
Electrode potentials, silver oxide electrodes; 1974
Electrode potentials, sulpholane; 1261
Electrode reactions, thermal batteries; 881
Electrode structures, honeycomb; 571, 575, 1896
Electrode structures, sandwich configurator; 2065
Electrode structures, uniform pore construction; 1896, 1931
Electrode structures, uniform thin film; 1931
Electrode supports, interaction with electrolytes; 1187, 1983
Electrode supports, materials; 888, 3312
Electrode tabs, extension; 1918
Electrode tabs, organic electrolyte cells, corrosion prevention; 922, 1026
Electrode tabs, welding techniques; 1583, 3221
Electrode tapes, preparation; 997, 998, 999, 1072, 1217
Electrode tapes, testing; 998
Electrodes, active area, nickel-cadmium cells; 489
Electrodes, amalgam, alkaline solution, 1204, 1633
Electrodes, amalgam, organics; 1466
Electrodes, cermet; nickel-cadmium batteries; 3243, 3257
Electrodes, comparison of thermodynamic properties; 1315
Electrodes, composite, preparation; 425

Electrodes, diffusion bonded; 3165
Electrodes, displaceable; 2080
Electrodes, duplex (See Bipolar electrodes)
Electrodes, fabrication; 181, 195, 262, 571, 572, 837, 2187, 3207, 3208, 3229, 3346
Electrodes, fabrication, lithium batteries; 1925
Electrodes, fabrication, zinc-oxygen cells, 659, 2048
Electrodes, foil, lead-acid 1958
Electrodes, foil, nickel-cadmium cells; 846
Electrodes, graphitic felt, nickel-cadmium cells; 775
Electrodes, high rate, 493
Electrodes, lithiated, 407, 607
Electrodes, porous, 181, 493, 638, 855, 1740, 3402
Electrodes, porous, behavior, 1576, 3015
Electrodes, porous, design; 1576, 2048, 3068
Electrodes, porous, electroless; 2047
Electrodes, porous, specific resistance; 1921
Electrodes, preparation, pocket type; 280, 1982
Electrodes, preparation, rolling; 509, 704
Electrodes, preparation, sintering, 718, 3107, 3242
Electrodes, ratio, positive-negative; 2118
Electrodes, reactions, solid state; 591
Electrodes, rotating ring-disc; 2040
Electrodes, screen; 429, 847
Electrodes, semiconductive; 1755, 3179
Electrodes, separator coated; 116, 636, 1831
Electrodes, separator wrapped; 769, 1617, 1689
Electrodes, sinter-frame; 638, 846
Electrodes, spiral winding; 2105, 3226
Electrodes, sponge; 199, 233, 302, 3154
Electrodes, stabilization; 607, 626
Electrodes, stabilization at elevated temperatures; 1257
Electrodes, stacked; 2105
Electrodes, thick, nickel-cadmium cells; 1631, 3244
Electrodes, thin; 542, 638, 669, 853, 1772
Electrodes, thin film; 159, 669, 1089, 1346, 1505, 1871, 1954
Electrodes, wet proofed; 719
Electrodes, wire; 226, 476
Electrolysis products, consumption; 86
Electrolyte, absorption; 607, 661, 1385
Electrolyte, additives, effect on performance; 1544, 3245
Electrolyte, additives, nickel-cadmium cells; 1547, 1986, 3245
Electrolyte, analysis; 1410, 1799, 3361
Electrolyte, capillary diffusion measurements; 1510, 2005
Electrolyte, capillary fed; 842
Electrolyte, circulating, nickel-zinc cells; 598, 1486
Electrolyte, circulating, zinc-air cells; 1167
Electrolyte, circulation; 53, 59
Electrolyte, concentration, nickel-cadmium cells; 77, 112, 303, 610, 716, 1608, 3085, 3361, 3363
Electrolyte, concentration, nickel-iron batteries; 1292
Electrolyte, concentration, nickel-zinc batteries; 1292

Electrolyte, concentration, silver-zinc cells; 515, 583, 725
Electrolyte, concentration, zinc-mercuric oxide batteries; 1901
Electrolyte, contamination; 327, 551, 606, 1579, 1770
Electrolyte, diaphragm, saturated; 854
Electrolyte, distribution between electrodes; 842, 1378
Electrolyte, drainage rate; 716
Electrolyte, flow-rate studies; 465, 879
Electrolyte, foaming, control by surfactants; 1057
Electrolyte, foaming, during charge; 1663
Electrolyte, as function of pore size; 1471, 1521
Electrolyte, gelatinous; 1772, 1917, 2056
Electrolyte, immobilization; 1894
Electrolyte, impurities, effects on dendrite formation; 746
Electrolyte, leakage; 1101, 3143
Electrolyte, loss, fuel cells; 864, 1056
Electrolyte, loss, nickel-cadmium cells; 17, 272, 297, 333, 358, 1654
Electrolyte, loss, nickel-iron cells; 851
Electrolyte, loss, silver-cadmium cells; 272, 499
Electrolyte, magnesium hydroxide; 161
Electrolyte, mixture of sulfuric acid and fluoboric acid; 363
Electrolyte, mobility; 672, 879
Electrolyte, modifications; 551
Electrolyte, molten chloride; 1442
Electrolyte, neutral sale; 238, 408
Electrolyte, organic compounds; 646
Electrolyte, percent of pore fillings; 633
Electrolyte, potassium hydroxide, addition of lithium hydroxide; 577, 587, 3245
Electrolyte, potassium hydroxide, addition of water; 596
Electrolyte, potassium hydroxide, concentration; 578
Electrolyte, potassium hydroxide, optimization; 1665
Electrolyte, potassium hydroxide, radiolysis; 239
Electrolyte, purification; 1472
Electrolyte, quantity, nickel-cadmium cells; 82, 96, 160, 272, 447, 468, 495, 713, 716, 1608, 1631, 1680, 1956, 2003
Electrolyte, quantity, silver-cadmium cells; 272, 645
Electrolyte, quantity, silver-zinc cells; 452, 495, 583, 651, 672, 713, 1587, 2134
Electrolyte, removal of Ca, alkaline batteries; 3323
Electrolyte, reservoirs, properties after sterilization (135 C); 1256
Electrolyte, reservoirs, sterilization studies; 1300
Electrolyte, stability, lithium batteries; 1795
Electrolyte, stability, voltage range; 1191
Electrolyte, static; 538
Electrolyte, swollen films; 439
Electrolyte, temperature; 725
Electrolyte, varying types, effects; 42
Electromagnetic properties, electrolytes, measurement; 1487
Electromagnetic relay; 625
Electron diffraction; 3353, 3354, 3365, 3367
Electron microscopy techniques, nickel; 647, 1408
Electron microscopy techniques, zinc; 786, 1426A, 3354
Electron microscopy, cadmium; 3353, 3354, 3365, 3367, 3370
Electron microscopy, magnesium; 3354
Electron paramagnetic resonance studies; 3238

Electron paramagnetic resonance studies, propylene carbonate; 1025
Electron spectroscopy; 3195
Electronic analog simulation; 461
Electronic conductance; 3196
Electronic equipment batteries; 1689
Electronic flash units; 119
Electronic switches; 98, 377, 512, 770
Electro-osmotic flow through separators; 879, 887
Electro-osmotic solvent transport; 1182
Electro-osmotic water removal, organic electrolytes; 1444
Electropositive metal additives; 719
Electrorefining; 3397
Electronminning of metals; 3397
Elongate-bundle fabrication; 1896
Emergency power supplies; 265
End-of-charge signal devices; 497
End-of-charge voltage shift, sterilized nickel-cadmium cells; 1299, 1378
Energy balance, electric power; 2068
Energy balance, fuel cells; 782A
Energy balance, organic electrolyte batteries; 1095
Energy conervation devices, review; 64, 269
Energy conversion systems, velocity acceleration profiles; 2143
Energy densities, cadmium-air cells; 879, 887, 1334, 1339, 2103
Energy densities, cadmium-oxygen cells, 820, 1343
Energy densities, circulating electrolytes; 538
Energy densities, comparison, batteries; 1335, 1962
Energy densities, cupric chloride-lithium system; 1797
Energy densities, halide systems; 1839
Energy densities, lead-acid cells; 66, 1315
Energy densities, lead-air cells, 887, 1176
Energy densities, lithium cells, 416, 1033, 1085, 1087, 1089, 1103, 1177, 1690, 1691, 2050, 2114
Energy densities, lithium-copper fluoride cells; 1793, 1810
Energy densities, lithium-cupric sulfide cells; 1260
Energy densities, lithium-cuprous chloride cells; 1877
Energy densities, lithium-selenium cells; 1260
Energy densities, magnesium dry cells; 1506
Energy densities, magnesium-manganese dioxide reserve batteries; 2104
Energy densities, mathematical analysis; 1093
Energy densities, mercury-cadmium cells; 1812
Energy densities, metal-air cells; 212, 1353
Energy densities, metal-oxygen cells; 1260
Energy densities, nickel-cadmium cells; 33, 66, 193, 416, 771, 793, 912, 1315, 1349, 1941, 2063, 3380
Energy densities, nickel-iron cells; 66, 1349, 1544
Energy densities, nickel-zinc cells; 1544, 1880
Energy densities, non-aqueous batteries; 871
Energy densities, organic electrolyte cells; 949, 1184, 1191, 1522, 1523, 1599, 1947
Energy densities, polycarbon monofluoride; 2036
Energy densities, primary cells; 7, 212, 462, 506, 1178, 1191
Energy densities, secondary cells; 1, 3, 7, 10, 64, 65, 211, 321, 462, 506, 1178, 1191
Energy densities, silver-cadmium cells; 66, 193, 212, 1349

Energy densities, silver oxide cells; 1350
Energy densities, silver-zinc cells; 66, 193, 212, 313, 329, 330, 416, 423, 1099, 1252, 1302, 1315, 1348, 1349, 1626
Energy densities, theoretical, metal halide-lithium couples; 1519
Energy densities, zinc-air cells; 887
Energy densities, zinc-oxygen cells; 494, 2145
Energy loss, electrodes; 175, 912
Engine starting batteries; 497
Engineering data, lead-acid cells; 1179
Engineering data, Leclanche' cells; 1179
Engineering data, mercuric oxide cells; 1179
Engineering data, nickel-cadmium cells; 1179
Enthalpy change (See Heat of reaction)
Entropy change; 550, 16
Entropy change, dimethylsulfoxide-lithium chloride electrolytes; 1112
Entropy change, lead-acid cells; 1174
Entropy change, lithium-silver chloride cells; 1119
Environmental testing; 47, 322, 401, 421, 450, 487, 511, 1053, 1141, 1213
Equilibrium constants, propylene carbonate-lithium-aluminum chloride electrolytes; 1126
Equilibrium constants, propylene carbonate-silver chloride electrolytes; 1128
Equilibrium constants, propylene carbonate-water mixtures; 1907, 2049
Equipment, cell cycling; 1258
Equipment, orbital vehicle, temperatures; 470
Equivalent circuit components; 584
Error analysis, preparator measurements; 1735
Ethyl formate, chromatographic analysis, 995
Ethylacetate solvents; 1329
Ethylene carbonate-dimethoxyethane electrolyte; 1746
Ethylene carbonate-lithium perchlorate electrolytes; 150 , 1886
Ethylene carbonate-propylene carbonate solvents; 946, 1091
Ethylene carbonate solvents; 1792
Ethylene carbonate solvents, preparation; 1502, 1886
Ethylene carbonate solvents, properties; 1502
Ethylene carbonate-sulfur dioxide solvents; 1533
Ethylene glycol additions, electrodes; 318, 426
Ethylene glycol sulfite electrolytes; 1849
Ethylene sulfite solvents; 1926
Ethylenediamine additions, organic electrolytes; 1241
Europium, properties in organic solvents; 1232
Evaluation programs; 189, 190, 191, 199, 399, 539, 654, 784, 828, 900, 1842
Evaluation tests, lithium batteries, 2050
Evaluate current, aluminum chloride melts; 1671
Exchange current, alkaline batteries; 3269
Exchange current, fused salts; 1839
Exchange current, lithium, in propylene carbonate; 1569
Exchange current, silver halide film formation; 1911
Exchange current, sodium in propylene carbonate; 1905
Expanders, cadmium electrodes; 43, 1547, 3392
Expanders, doping additives, cadmium electrodes; 1334, 1339, 3392

Expansions, lead electrodes; 1920
Experiments, fractional factorial; 764
Explorer satellites (See Atmosphere explorer orbiting vehicle batteries)
Extended time tests; 561
Extenders, additives, cadmium electrodes; 1334, 1339
Extrude-and-sinter fabrication; 1896

F

Fabrics, impregnation; 1872
Factorial design, cell testing; 1544, 3398
Factorial design experiment; 1422, 1902
Factorial design experiments, nickel-cadmium cells; 1630, 1710, 3103, 3398
Factorial testing, iron electrodes; 1291
Factorial testing, nickel-cadmium cells; 1378
Factorial testing, nickel electrodes; 447, 1292
Factorial testing, nickel fluoride electrodes; 1211
Factorial testing, silver electrodes; 583
Factorial testing, zinc electrodes; 1292
Failure analysis, 582, 683, 2096, 3070
Failure analysis, computer programs; 921, 1225
Failure analysis correlation, nickel-cadmium cells; 1482
Failure analysis, nickel-cadmium cells; 47, 67, 101, 123, 189, 190, 205, 206, 309, 362, 371, 402, 466, 473, 483, 604, 652, 681, 733, 921, 1225, 1627, 1727, 1747, 2007, 2084, 3012
Failure analysis, nickel-zinc cells; 1880
Failure analysis, procedures; 708, 777, 1340
Failure analysis procedures, nickel-cadmium cells; 1220, 1377, 1410, 3231, 3237
Failure analysis procedures, silver-zinc cells; 1377, 1390, 1410, 1426
Failure analysis, silver-cadmium cells; 190, 206, 362, 499, 604, 652, 1068, 1732, 3066
Failure analysis, silver-zinc cells; 101, 189, 190, 206, 234, 235, 309, 362, 402, 466, 515, 561, 581, 583, 604, 612, 652, 915, 970, 1452, 1468, 1601, 1801, 1838, 1975
Failure analysis terms, definitions; 806, 3237
Failure analysis, voltage characteristics; 921
Failure, causes; 539, 635
Failure, causes, nickel-cadmium cells; 1956
Failure, cycle pattern; 803
Failure data and mechanisms, nickel-cadmium cells; 1410
Failure data and mechanisms, silver oxide-zinc cells; 1410
Failure data, nickel-cadmium cells; 728
Failure, definition; 777, 800, 1152, 1176, 1410
Failure determinant, definition; 777, 1410, 3237
Failure distribution, estimation; 1173
Failure due to sterilization; 673
Failure frequency, nickel-cadmium cells; 1225
Failure, fuel cells, causes; 864

Failure, internal short; 612, 632
Failure, lithium batteries, 2052
Failure, lithium-copper fluoride batteries, 988
Failure mechanisms, definition; 777, 1410, 3237
Failure mechanisms, nickel-cadmium cells; 1385, 1842, 2020, 3070, 3404
Failure mechanisms, nickel electrodes, 1871
Failure mechanisms, sealed cells; 1152, 1377, 3070
Failure models; 1173
Failure mode, cadmium electrode; 3378
Failure modes, analysis of converter; 790A
Failure modes, cadmium-air cells; 1334, 1339
Failure modes, cadmium-oxygen cells; 920
Failure modes, definition; 777, 1410
Failure modes, nickel-cadmium cells; 586, 908, 1294, 3008, 3020
Failure modes, nickel-zinc batteries; 2066
Failure modes, seals; 2106
Failure modes, separator material tests; 1658
Failure modes, silver-cadmium cells; 2194
Failure modes, silver-zinc cells; 968, 2067
Failure predictions; 803, 805
Failure predictions; methods; 1225, 2132, 2133, 3233
Failures, classification; 892
Failures, descriptions; 892
Failures, effects of environment; 1482
Feasibility studies; 880
Ferric oxide additions, cadmium electrodes; 2057, 3392
Fiber metal plaques; 3382
Fibrid separators; 1316
Field temperature effects; 605
Figure of merit, battery performance, 1087
Figure of merit, organic electrolytes; 1095
Filler materials, paste electrolytes; 1779
Films, cadmium hydroxide; 1376, 1970, 2054
Films, anisotropic characterization; 1707
Films, casting; 896
Films, formation on cadmium; 2040
Films, growth determination; 1346
Films, methanol treated; 966
Films, preparation for separators; 966, 1488, 1639, 1640, 1707
Filters, band pass; 588
Fischer analysis, organic solvents; 1075
Fischer number; 3382
Flade potential; 3369
Flame-spraying technique; 665
Flight data, Discoverer orbiting vehicle; 470
Flight data, Mariner spacecraft; 670, 1803, 3146
Flight data, OGO orbiting vehicle; 471, 472
Flight history, nickel-cadmium batteries, 20 ampere hour; 1527
Flight tests, CF-100 aircraft; 605
Float operation, elevated temperature; 1206
Flock fabrication; 1896, 1931
Flooded cells; 557, 630, 658
Flooded sealed cells; 701

Fluoride additions, electrolytes; 83
Fluoride electrodes; 1184
Fluoride intercalates; 1670, 1685
Fluoride solutes; 925, 967, 990
Fluoride solutes; purification; 1295
Fluorides, electrochemical preparation; 1097
Fluorine batteries; 416
Fluorine intercalates; 1763
Fluoroarsenate solutes; 960
Fluoroborate solutes; 932, 960
Fluoroborate solutes, organic electrolytes; 906
Foil electrodes; 148, 159, 326, 1545
Formaldehyde additions, silver electrodes; 1789
Formamide electrolytes; 1372, 1373
Formamide solvents, physical properties; 1485
Formation cycle devices; 1520
Formation cycle devices, automatic; 917
Formation cycling; 1459, 1457
Free charge carriers; 3328
Free convection analysis; 864
Free energy of formation, borides; 1495
Free energy of formation, carbinides; 1495
Free energy of formation, chlorides; 1320, 1332, 2049
Free energy of formation, copper fluoride; 988
Free energy of formation, fluorides; 1320, 1332, 1495
Free energy of formation, oxides; 1320
Free energy of formation, silver fluoride; 1031
Free energy of solvation; 1679
Freezing, nickel-cadmium cells; 477
Freezing points, electrolytes, silver-zinc cells; 1365
Freezing points, fused salts; 1839
Freezing points, organic electrolytes; 1163
Frothing problem, separators; 660
Fuel cell applications; 811, 1832, 3025
Fuel cell batteries, design; 2083
Fuel cell batteries, hydrox, pulse applications; 1356
Fuel cell electrodes; 434, 508, 619, 1250, 2082
Fuel cell performance decay with impurity build-up; 1056
Fuel cell scavenger electrodes; 508, 619, 762
Fuel cells; 657, 705, 2042, 2048, 2060, 2061, 3387
Fuel cells, bibliography; 965, 3387
Fuel cells, immobilized electrolytes; 864
Fuel cells, micro, pressure control; 823, 1252
Fuel cells, miniature, hybrid; 889
Fuel cells, performance decay; 864, 1844
Fuel cells, purging operation; 864
Fused salt cells; 700
Fused salt electrolyte systems; 643
Fused salt electrolytes, conductivities; 1077
Fused salt electrolytes, lithium-chlorine cells; 1246

G

Gallium additions, electrolytes, 76
Galvanic gas monitoring; 755
Galvanostagometry techniques; 1862
Galvanostatic charging, techniques, 742
Galvanostatic pulse measurements, cadmium electrodes; 2054
Galvanostatic pulse measurements, lithium-silver sulfide cells; 1787
Galvanostatic pulse measurement, lithium surfaces, 1569
Galvanostatic screening tests, organic electrolytes, 993
Galvanostatic techniques; 247, 594, 1879, 1916, 2062, 2129, 3369, 3371
Galvanostatic techniques, nickel-cadmium cells; 761, 3371
Gamma-butyrolactone solvents; 1926
Gamma-butyrolactone solvents, electro-osmotic removal of water; 1444
Gas adsorption technique, BET.; 826
Gas analysis, chlorine electrode cells; 1005
Gas analysis device, sealed cells; 1538, 3036
Gas chromatography, organic solvents, 1075, 1565, 1603
Gas contamination, nickel-cadmium cells, 1956
Gas evolution, battery electrodes; 2075, 3054, 3061 - 3065, 3113, 3215, 3219, 3225
Gas evolution, detection technique, 1862
Gas evolution, measurement apparatus; 1291
Gas evolution, measurement techniques; 754, 1101
Gas evolution, silver-cadmium cells; 1884
Gas generation, sealed cells; 737
Gas generators, battery activation; 1467
Gas manifolds, silver zinc batteries; 1468
Gas plumbing, cycle tests; 655
Gas recombination capabilities, zinc electrodes; 1771
Gas recombinations, nickel-iron cells; 831
Gas recombination rates; 199, 275, 305
Gas recombination, silver-zinc cells; 1601
Gas removal; 68, 170
Gas venting techniques;
Gassing, nickel-cadmium cells; 81, 91, 188, 1172, 2065, 2077, 2119
Gassing, nickel electrodes; 596, 730, 2118, 3061, 3062
Gassing, rates, lithium-propylene carbonate system; 1976
Gassing, rates, silver electrodes; 1369, 1404
Gassing, rates, silver-zinc cells; 208, 233, 783, 823, 889, 1221, 1252, 1369, 1390, 1588
Gassing, sealed batteries, 2130
Gassing, zinc electrodes; 662, 866, 1901, 2006
Gemini spacecraft batteries; 432
Germanium additions, potassium hydroxide; 721
Germanium additions; silver oxide samples, 1593
Gibbs free energy change, dimethylsulfoxide-lithium chloride electrolytes; 1112
Glass electrodes, sensitive to lithium ions; 1086, 1113, 1329
Glass screen separators; 773
Gold plaques, impregnation; 1546

Gold plaques, nickel electrode preparation; 1546
Gold plated platinum electrodes; 607
Gold-silver alloys; 807
Grafting solutions, effects on properties; 1488
Graphite additions, cadmium electrodes; 1607, 1608
Graphite additions, copper fluoride electrodes; 1792
Graphite additions, nickel electrodes; 140, 216, 602, 2154
Graphite electrodes, ammonia electrolytes, 1276
Graphite electrodes, in organics; 1946, 2052
Graphite electrodes in propylene carbonate electrolyte, 1565
Graphite-fluorine compounds, reduction; 1121
Graphite intercalates, positive electrodes, 1670, 1685
Graphite purification; 1241
Gravitational acceleration tests; 595, 597
Grids, circular, pure lead, design, 1767
Grids, corrosion in lead-acid cells, accelerated tests; 1767
Grids, corrosion in lithium-copper chloride cells; 1280
Grids, design; 1860
Grids, embrittlement by mercury; 1459
Grids, lead, dispersion strengthened; 1960
Grids, overvoltage study; 1568
Grids, pure lead, polarization data; 1769
Grids, silver, embrittlement; 1473
Grids, vibration resistant, 429

H

Halogen alkali metal primary cells; 416
Halogen fluoride batteries, patents; 1814
Haloisocyanoric acids, organic electrodes; 1847
Hardware design, primary batteries; 732
Hearing-aid batteries; 222
Heat absorption, silver-zinc cell components; 464, 511
Heat balance calculations, balloon batteries; 1287
Heat balance calculations, nickel-cadmium cells; 1100, 1439
Heat balance calculations, silver-cadmium cells; 1439
Heat balance calculations, silver-zinc cells; 790, 1439
Heat capacity (See Specific heat)
Heat dissipation (See Heat losses)
Heat effects (See Thermal effects)
Heat evolution, magnesium-manganese dioxide dry cells; 1371
Heat exchangers, construction; 867
Heat exchangers, prototype, silver-zinc cells; 464, 465
Heat generation, lithium-copper chloride cells; 961
Heat generation, lithium-silver chloride cells; 937, 940, 1119
Heat generation, magnesium batteries; 463
Heat generation, nickel-cadmium cells; 1100, 1108, 1254, 1285, 1301, 1439, 1647, 1869, 3034, 3373

Heat generation-polarization relationships; 548, 1100
Heat generation, prediction, 1439, 1637, 3034
Heat generation, silver-cadmium cells; 1439
Heat generation, silver-zinc cells; 757, 1337, 1439, 1815
Heat generation, slabs; 1054
Heat losses, cells; 196, 462, 641, 811, 1100
Heat losses, lead-acid cells; 120
Heat losses, lead wires; 462, 579, 1100
Heat losses, magnesium batteries; 463
Heat losses, nickel-cadmium cells; 11, 120, 1100
Heat losses, zinc-air cells; 494
Heat pipes, nickel-cadmium cells; 1647, 1971, 1990, 2079, 2097
Heat of reaction, dimethylsulfoxide-lithium chloride electrolytes; 1112
Heat of reaction, lead-acid cells; 120, 1174
Heat of reaction, lithium-copper fluoride cells; 986
Heat of reaction, lithium-silver chloride cells; 937, 940, 1119
Heat of reaction, measurement; 550, 1637
Heat of reaction, metal chlorides; 1320, 1332
Heat of reaction, metal fluorides; 1320, 1332
Heat of reaction, metal oxides; 1326
Heat of reaction, nickel-cadmium cells; 120, 449, 530, 650, 1100, 1108, 1136, 2093
Heat of reaction, nickel-cadmium, lithium hydroxide cells; 449, 650
Heat of reaction, related to cell polarization; 548, 1100
Heat of reaction, silver-zinc cells; 464, 465, 1100
Heat sinks, aluminum; 628, 1100
Heat sinks, design for stabistors; 203, 1453
Heat sources, low temperature batteries, analysis; 643
Heat sterilizable nickel-cadmium cells; 788, 832, 1378, 1401, 1432, 1630, 1631, 1632, 3006
Heat sterilizable nickel-cadmium cells, performance; 733, 734, 832, 1259, 1299, 1454
Heat sterilizable separators; 436, 437, 484, 522, 537, 661, 690, 709, 735, 792, 860, 884, 966, 1170, 1171, 1203
Heat sterilizable silver-zinc batteries, reserve; 1256
Heat sterilizable silver-zinc cells; 450, 662, 673, 736, 788, 888, 1137, 1293, 1587, 1588, 1636, 1638, 1800, 1801, 1834, 1835, 1975
Heat sterilizable silver-zinc cells, electrolyte studies; 745
Heat sterilizable silver-zinc cells, fabrication; 1363
Heat sterilizable silver-zinc cells, performance; 662, 664, 673, 737, 866, 888, 1422, 1459, 1473
Heat sterilizable silver-zinc cells, remotely activated; 788, 1300, 1369, 1417, 1467
Heat sterilization, duration; 1588
Heat sterilization techniques; 673, 1051
Heat sterilization tests; 441
Heat transfer (See also Diffusion equation); 782C, 864, 1340, 1341
Heat transfer, conduction in cells; 691, 708, 1100, 1377, 3060
Heat transfer, effect on activity coefficients; 1383

Heat transfer, effects of cell geometry; 543, 1100
Heat transfer, electrochemical systems; 782, 1050, 1318, 1360, 1844, 3145
Heat transfer, fuel cell batteries; 782A, 782A, 782B, 782C, 2083
Heat transfer, porous media; 1056
Heat transfer, zero gravity; 511
Heated batteries, development; 462, 579, 643
Heater calibration, calorimeters; 867, 1428
Heater circuits, calorimeters; 650
Heater insulation systems; 462
Heaters, batteries; 462, 579, 643
Heaters, internal, nickel-cadmium cells; 1428
Heats of solution, alkali metal halides in organic solvents; 1312
Helicopter batteries, silver-cadmium; 421
Hexafluoroarsenate solutes; 1155
Hexafluorophosphate solutes; 936, 938, 939, 941, 946, 947, 948, 971, 972, 973, 975, 976, 990, 1030, 1042, 1091, 1155, 1329
High energy batteries; 700, 705, 807, 871, 881, 1445, 1448, 1523, 1543, 1670, 1685, 1689, 1792, 1793, 1797, 1880, 1910
High energy batteries, reviews; 1125, 1133, 1294, 1328, 1351
High energy density cells; 1794, 1877, 1941, 2045, 2048, 2114, 3072, 3088, 3096, 3097, 3122
High energy density cells, military application; 1664
High energy density cells, silver-zinc; 1626
High energy density cells, space applications; 1528
High energy primary cells; 101, 1386, 1810
High energy protons; 374
High energy secondary cells; 101, 450, 491, 506, 771, 1386, 3094
High energy short duration batteries; 880
High pulse rate batteries; 771
High rate batteries; 1575
High temperature alkaline cells; 1477
High temperature batteries; 1076, 1077, 1078, 1294
High temperature batteries, design; 1078
High temperature effects, nickel-cadmium batteries; 727
High temperature effects, nickel-cadmium cells; 908
High temperature operation, silver-zinc cells; 450, 876
High temperature performance, primary cells; 1178
High temperature performance, secondary cells; 1178
High temperature tests, silver-zinc cells; 595
History, batteries; 24, 255, 1344
Honeycomb structures; 571, 575, 1896, 2045, 3092
Hydraulic pressure techniques; 653
Hydrazine-oxygen cells; 700
Hydrogen absorbing materials, palladium; 1745
Hydrogen absorption rates; 783, 823, 889, 1252
Hydrogen absorption energy; 1501
Hydrogen-air fuel cells, status; 1286
Hydrogen bonding, nickel hydroxide electrodes; 1928
Hydrogen bonding, role in aprotic media; 1342
Hydrogen combination cells; 674

Hydrogen control devices; 420
Hydrogen diffusion, metallic surfaces; 2081
Hydrogen evolution, cadmium electrodes; 93, 454, 760, 1476, 2065, 2077, 3113, 3365
Hydrogen evolution, control; 859, 3215, 3225
Hydrogen evolution during irradiation, silver-cadmium cells; 795
Hydrogen evolution, lead-acid cells; 1063
Hydrogen evolution, low temperature; 648
Hydrogen evolution, magnesium-manganese dioxide dry cells; 1371
Hydrogen evolution, nickel-cadmium batteries, 355, 442, 772, 1630, 3215
Hydrogen evolution, nickel-cadmium cells, prevention; 107, 108
Hydrogen evolution nickel electrodes; 92
Hydrogen evolution rates, monitoring; 755
Hydrogen evolution rates, temperature effects; 1063
Hydrogen evolution, silver-cadmium cells; 674
Hydrogen evolution, silver-zinc batteries; 250, 490, 624, 635, 674
Hydrogen evolution, suppression; 633
Hydrogen evolution, zinc electrodes; 1486, 1699, 1893
Hydrogen fluoride electrolytes; 1097
Hydrogen overvoltage apparatus; 624
Hydrogen overvoltage phenomena; 1501, 3050, 3052, 3113, 3114, 3140, 3225, 3389
Hydrogen overvoltage on zinc; 1330
Hydrogen permeation cell; 2081
Hydrogen peroxide; 3385
Hydrogen pressure control; 598
Hydrogen pressure protection; 569
Hydrogen recombination electrodes; 829, 1629
Hydrogen reference electrodes, organic electrolytes; 1229
Hydrostatic pressure cell; 2081
Hydroxyl ion gradient, zinc electrodes; 1194
Hydroxyl migration; 1488
Hyuck metal plaques; 438, 1451

I

Immobilized electrolyte fuel cell systems; 1056
IMP satellites; 631, 1334
Impact resistant nickel-cadmium cells; 866, 1432, 1630, 1631, 1632
Impact resistant silver-cadmium cells; 662
Impact resistant silver-sinc cells; 662, 663, 737, 866, 888, 1137, 1293, 1363, 1459, 1473, 1587
Impact testing, nickel-cadmium cells; 1401, 1432, 1454, 1632
Impedance, electrochemical; 2026, 3150, 3153
Impedance, function of state-of-charge; 373, 584, 1549, 1550
Impedance measurements; 2148
Impedance measurements; cadmium electrodes, 2009, 2034
Impedance measurements, Leclanche' cells; 1323
Impedance measurements, lithium-nickel fluoride cells; 573
Impedance measurements, nickel-cadmium cells; 544, 799, 802, 1101, 1317, 1918, 2033
Impedance, phase boundry; 3153

Impedance, structural; 2034
Implantable cells; lithium-selenium; 1779
Impregnating solution, cadmium acetate; 1409
Impregnating solution, cadmium nitrate; 1409
Impregnating solution, pH control during anodic polarization; 882
Impregnating solutions; aluminum and ammonium salts; 1983
Impregnation, cadmium electrodes; 718, 3074, 3075, 3076, 3129, 3230, 3249
Impregnation, cathodic precipitation; 686, 908, 1427
Impregnation, Edison process; 1455
Impregnation, Fleischer method; 3383
Impregnation, fused salt method; 905
Impregnation, high temperature; 3086
Impregnation, Kandler process; 904, 1427
Impregnation, parameters; 445, 446, 467, 1620, 3088, 3129, 3141, 3157, 3161, 3383
Impregnation, plaque corrosion; 1983
Impregnation, ultrasonic utilization; 1935
Impregnation, vacuum method; 905, 1409
Impurities, effects on electrode reactions; 74, 75, 327, 336, 355, 502, 730, 807, 3002
Impurities, effects on overpotential measurements; 780
Indium additions, cadmium electrodes; 640, 1409, 2057, 3295, 3384
Indium additions, electrolytes; 76
Indium dry primary cells; 4, 7
Indium electrodes, organic electrolytes; 981, 982
Indium systems, organic electrolytes, 1305
Information systems; 1220
Information systems, personalized; 1845
Infrared absorption, analyses; 444, 675
Infrared absorption, battery charge-discharge compound; 1929
Infrared absorption frequencies; propylene carbonate; 1584
Infrared analysis, propylene carbonate; 971, 1603
Infrared emitting device, battery condition detector; 1929
Infrared spectroscopic investigations; 552, 902, 1577, 3139, 3335
Inorganic additions, zinc electrodes; 1452
Inorganic electrolyte systems, patents; 1814
Inorganic fibrous support matrix; 450
Inorganic separators; 208, 437, 490, 496, 636, 690, 705, 709, 735, 876, 1109, 1221, 1418, 1477, 1732, 1831, 1880, 2150, 2161, 2168
Inorganic separators, composition and process; 1826
Inorganic separators, lithium batteries; 1115
Inorganic separators, nickel-zinc cells; 2066
Inorganic separators, properties and manufacturing processes; 1353
Inorganic separators, silver-zinc cells; 1390, 1555, 1801
Inorganic separators, sintered; 964, 2126
Inorganic separators, zinc-oxygen cells; 1472
Inorganic solutes, lithium battery electrolytes; 1586
Inorganic solvents, screening; 1235
Input capacity, variations with temperature; 734
Inspection instructions; 621
Inspection procedures; 1499, 1500

Instrument selection guide; 1101
Instrumentation; 97, 189, 190, 339, 381, 588, 658, 664, 3018, 3195
Instrumentation, half-cell studies; 1095
Instrumentation, half-cell testing, design; 1093
Instrumentation, membrane characteristics; 1972
Instrumentation, programmed galvanostatic studies; 742
Instrumentation systems; 1141
Insulation, batteries; 462, 579, 643
Integrated instrument systems; 883
Intercalate compounds; 1670, 1685, 1763
Interleafing electrode design; 566
Internal pressure devices; 2096
Internal pressure, effects of cell pack tightness, 737
Internal pressure, effects on cycle life; 42, 1250
Internal pressure, effects of electrolyte in separators; 818
Internal pressure, effects of surface area of cathode; 818
Internal pressure, effects of temperature; 818
Internal pressure, measurements; 88, 870, 2178
Internal pressure versus adhydrode signal; 619, 829
Internal resistance, adhydrodes; 890
Internal resistance, Leclanche' cells; 1323
Internal resistance, lithium batteries; 973
Internal resistance, measurement; 658, 770, 2101
Internal resistance, nickel-cadmium cells; 98, 198, 333, 358, 717, 890, 1219, 3037
Internal resistance, variation with temperature; 799
Iodine electrodes, organic electrolytes; 1902
Iodine oxide electrodes, polarization; 1133
Iodine pentoxide electrodes, organic electrolytes; 1016
Ion exchange membrane separators; 229, 1316
Ion exchange membranes, electrical resistivity; 1182
Ion exchange membranes, liquid ammonia batteries; 1092
Ion exchange membranes, organic electrolytes; 1759, 1902
Ion exchange membranes, utilization in coulometer; 1596
Ion exchange primary cells; 4
Ion exchange separators, organic electrolytes; 928, 991, 994, 1041, 1182, 1188
Ion exchange separators, stability in organic solvents; 1182
Ion exchangers; 1353
Ionic conductances, 1228, 3196
Ionic transport, organic solvents; 1946
IR-drop, elimination from overpotential measurements; 780
Iron additions, cadmium electrodes; 19
Iron additions, nickel; 176, 280, 860, 3286
Iron additions, silver-zinc cells; 1250
Iron additions, zinc electrodes; 1202B
Iron chloride species, organic solvents; 1319
Iron contamination, nickel-cadmium cells; 1956
Iron electrodes, alkaline electrolytes; 1879
Iron electrodes, continuous fabrication; 638
Iron electrodes, discharge characteristics; 1879

Iron electrodes, electrochemical oxidation; 1879
Iron electrodes, organic electrolytes; 981, 982, 1001, 1305
Iron electrodes, passivation; 241
Iron electrodes, performance; 1879, 2101, 3251
Iron-lead primary reserve cells; 241
Iron migration nickel-cadmium cells; 907
Iron-nickel alloys, 594
Iron oxide, electrochemical reduction in battery electrodes; 280
Iron-oxygen cells, design; 1251
Iron-silver secondary cells; 4
Irradiation (See Radiation)
Isopropylamine-lithium perchlorate electrolytes; 1238
Isopropylamine-lithium perchlorate-selenium-sulphur electrolytes; 1396
Isopropylamine-lithium perchlorate-sulphur electrolytes; 1396

J

Joining techniques, case assembly; 1290, 3001

K

Kandler process; 904, 1427
Kordes-Marko bridge; 2031
Kordes techniques, state-of-charge indicators; 98, 2031
Krypton-85 powered devices; 1814

L

Lactone solvents, bibliography; 956
Lactones; 956
Lalande hydrogen peroxide depolarized primary cells; 10
Lalande oxygen depolarized primary cells; 10
Lalande wet primary cells; 4, 10, 64
Lasers, battery selections; 1750
Laser interferometry; 3373
Lead-acid batteries, accelerated test method; 1770
Lead-acid batteries, capacity loss on stand; 1424
Lead-acid batteries, cost data; 875
Lead-acid batteries, cycle life; 1424
Lead-acid batteries, cylindrical design; 1766, 1772, 1860
Lead-acid batteries, discharge performance; 1424
Lead-acid batteries, electrode polarization; 1769
Lead-acid batteries, energy densities; 1424
Lead-acid batteries, float operation; 1768
Lead-acid batteries, forecast; 2089
Lead-acid batteries, jelly-roll design; 1957, 1958
Lead-acid batteries, maintenance-free; 1424, 1876

Lead-acid batteries, material testing; 1770
Lead-acid batteries, patents; 1814, 1957, 1958
Lead-acid batteries, performance; 875, 1052, 2101
Lead-acid batteries, review; 1294, 1944
Lead-acid cells; 3, 4, 7, 10, 31, 40, 64, 65, 66, 80, 118, 211, 260, 264, 265, 267, 295, 316, 317, 466, 479, 549, 574, 605, 850, 885, 1811, 1860, 1917, 2069, 2072
Lead-acid cells, dry, patents; 1814
Lead-acid cells, pasted positive plates; 1345, 2072
Lead-acid cells, rechargeable; 1876
Lead-acid cells, research problems; 1811
Lead-acid cells, secondary; 295, 1344, 2061
Lead additions, alkaline electrolytes; 1304, 1904
Lead additions, silver electrodes; 275, 583, 1429
Lead additions, silver oxide samples; 1593
Lead additions, zinc electrodes, 502, 12028, 1221, 1256, 1289, 1390, 1406, 1422, 1882, 2006, 2182
Lead-air batteries, calculations; 887
Lead-air systems; 879
Lead-calcium acid cells; 7, 101
Lead-calcium batteries, accelerated testing; 1206
Lead-calcium grids; 7, 69
Lead-cast, current connectors; 1825
Lead chloride electrodes, organic electrolytes; 957
Lead chloride, passivation in organic electrolytes; 957
Lead chloride, solubility in organic electrolytes; 957, 1049, 1160, 1280
Lead chloride solutes; 957
Lead compacts, fabrication; 899
Lead dioxide, chemical characterization; 1811
Lead dioxide electrodes, characterization; 2069
Lead dioxide electrodes, cycling; 1811
Lead dioxide, entropy; 1174
Lead dioxide, heat capacity; 1174
Lead dioxide, polymorphism; 1811
Lead dioxide, resistivity; 1811
Lead dioxide, solubility in sulfuric acid; 1174
Lead dioxide, X-ray analysis; 1811
Lead electrodes, alloy; 1959
Lead electrodes, arsenic additions; 1959
Lead electrodes, blister formation; 2079
Lead electrodes, preparation; 2072
Lead electrodes, silver additions; 1959
Lead electrodes, sponge; 2069
Lead electrodes, surface layer; 2073
Lead electrodes, tellurium additions; 1959
Lead fluoride, solubility in organic electrolytes; 1180
Lead-lead dioxide reserve cells; 7
Lead oxide, electrochemical reactions; 2072

Lead oxide electrodes, organic electrolytes; 928, 944
Lead oxide surface coating on lead grids; 1960
Lead peroxide electrodes; 1917, 2056
Lead plates, high surface area; 1575
Lead plates, morphology; 1870
Lead-silver alloy electrodes; 807
Lead-silver alloy electrodes, preparation; 1772
Lead-silver cells, patents; 1814
Lead-silver oxide secondary cells; 7
Lead storage cells, thermodynamic properties; 1174
Lead sulfite, reduction; 2073
Lead thiocyanate complexes in dimethylformamide; 1743
Leclanche' cells; 3, 4, 7, 10, 64, 462, 479, 797, 877, 913
Leclanche' cells, maintenance-free; 1876
Leclanche' cells, status; 1286, 1944
Leclanche'-type cells using lithium; 1284
Life cycle data; 1515, 3019, 3032
Life cycling, cadmium-air cells; 2193
Life cycling capability, silver-cadmium cells; 1732
Life cycling, nickel-cadmium cells; 17, 30, 806, 1842, 2096, 3012, 3019, 3232, 3375
Life cycling, programs; 533, 606, 683, 1727
Life cycling, silver-cadmium cells; 806, 1842, 2096
Life cycling, silver-zinc cells; 806, 1473, 1842, 2096
Life tests, accelerated; 708, 777, 915, 3011
Life tests, nickel-cadmium cells, -10C and 25C; 1807
Life tests, simulated; 708
Life tests, simulated orbital; 915
Liquid ammonia batteries; 643, 700, 703, 1053, 1071, 1092, 1093, 1189, 1276, 1277, 1810
Liquid ammonia batteries design; 1242, 1478
Liquid ammonia batteries, low temperature operation; 1105, 1294
Literature reviews, batteries; 706, 777, 915, 3381
Lithium additions, alkaline electrolytes; 1407, 1856, 2087, 3054
Lithium additions, electrolytes; 19, 36, 62, 139, 228, 278, 327, 367, 378, 392, 478, 606, 817, 1292, 3054
Lithium additions, nickel electrodes; 3286, 3301
Lithium additions, potassium hydroxide; 577, 587, 727, 905, 1993, 2066, 2164
Lithium-air cells, stability and solvent losses; 1355
Lithium alloys, formation in propylene carbonate; 2010
Lithium-aluminum chloride-butyrolactone electrolyte; 2037
Lithium-aluminum chloride-butyrolactone solution; 2053
Lithium-aluminum chloride preparation; 958, 1001
Lithium-aluminum chloride solutes; 939, 942, 951, 952, 957, 958, 961, 1244, 1269, 1503
Lithium-aluminum chloride solutes, conductivity; 1389
Lithium-aluminum electrodes; 1887
Lithium-aluminum electrodes, performance; 1 25
Lithium based solutes; 1166
Lithium batteries; 807, 1227, 1849, 1850, 1851, 2108
Lithium batteries, applications; 1006

Lithium batteries, comparisons with other battery systems; 1033, 1214
Lithium batteries, design; 1089, 1351, 1387, 1446, 1670, 1685, 2050, 2188
Lithium batteries, energy densities; 1027, 1028, 1386
Lithium batteries, efficiency; 1031
Lithium batteries, low temperature operation; 1116
Lithium batteries, patent review; 1659
Lithium batteries, patents; 1754, 1755, 1775, 1902
Lithium batteries, rechargeable; 1394, 1903, 1924, 1943, 2002, 2043, 2078, 2166
Lithium batteries, reserve; 1851
Lithium batteries, review; 1027, 1914, 1973
Lithium batteries, review by industrialists; 1033
Lithium batteries, screening; 993
Lithium batteries, sealed; 941
Lithium batteries, shelf life; 1914
Lithium batteries, testing apparatus; 942
Lithium batteries, weight analysis; 1028
Lithium bromide, conductance measurements in propylene carbonate; 1402
Lithium bromide solutes; 954, 1415
Lithium bromide, thermodynamics in propylene carbonate; 1461
Lithium bromide, viscosity measurements; 1462
Lithium-bromine rechargeable cells; 1493
Lithium-cadmium chloride batteries; 1950
Lithium-cadmium fluoride cells; 1209
Lithium cell materials, compatibility with electrolytes; 1586
Lithium cells; 1543
Lithium cells, chronopotentiometry; 1016
Lithium cells, primary; 1763, 1774, 2114
Lithium cells, reviews; 1085, 1087, 1351
Lithium cells, thermodynamic analysis; 1597
Lithium chloride-aluminum chloride solutes; 1795
Lithium chloride, build-up at electrode surface; 1481
Lithium chloride, conductance measurements in propylene carbonate; 1462
Lithium chloride-dimethyl formamide electrolyte; 1394
Lithium chloride electrolytes; 1083
Lithium chloride film formation; 1443
Lithium chloride in organic solvents; 1543
Lithium chloride-potassium chloride electrolytes; 1077
Lithium chloride, solubility in dimethylformamide (25 C); 1485
Lithium chloride, solubility in formamide (25 C); 1485
Lithium chloride, solubility in n-methylformamide (25 C); 1485
Lithium chloride, solubility in propylene carbonate; 1126, 1628
Lithium chloride solutes; 957
Lithium chloride, specific conductances (25 C); 1485
Lithium chloride, thermodynamics in propylene carbonate; 1461
Lithium chloride, viscosity measurements; 1462
Lithium chloride-zinc chloride dry primary cells; 4
Lithium-chlorine cells, 1018, 1082, 1083, 1216

Lithium-chlorine cells, design; 1004, 1005, 1082, 1237, 1246, 1923
Lithium-chlorine cells, performance; 1246
Lithium-chlorine cells, reviews; 1034, 1035
Lithium-chlorine cells, voltage in lithium chloride; 1005
Lithium-chlorine interactions; 1084
Lithium-chlorine secondary cells; 1035
Lithium-cobalt fluoride cells; 986, 990
Lithium-cobalt fluoride cells, testing; 1308
Lithium-copper chloride cells; 871, 1072, 1095, 1188, 1327, 1386, 1534, 1759, 1774, 1850
Lithium-copper chloride cells, effects of impurities; 1244, 1269
Lithium-copper chloride cells, performance data; 1177
Lithium-copper chloride cells, wet-stand characteristics; 1187, 1309
Lithium-copper chloride primary cells; 1044
Lithium-copper chloride primary cells, efficiency over temperature range; 1044
Lithium-copper chloride primary cells, high temperature performance; 1044
Lithium-copper chloride primary cells, low temperature performance; 1044
Lithium-copper chloride primary cells, state-of-the-art; 1622
Lithium-copper fluoride batteries; 941, 959, 1760, 1927
Lithium-copper fluoride batteries, design; 989, 1247
Lithium-copper fluoride cells; 871, 953, 986, 990, 1000, 1011, 1014, 1015, 1032, 1073, 1095, 1097, 1104, 1106, 1129, 1133, 1155, 1186, 1238, 1241, 1247, 1288, 1327, 1502, 1886
Lithium-copper fluoride cells, design; 987, 988
Lithium-copper fluoride cells, dry storage investigations; 2793
Lithium-copper fluoride cells, mass transport; 1782
Lithium-copper fluoride cells, performance; 1792, 1793, 1810
Lithium-copper fluoride cells, performance, effects of solutes; 1155
Lithium-copper fluoride cells, preparation; 1086
Lithium-copper fluoride cells, self-discharge studies; 1793
Lithium-copper fluoride cells, testing; 1308, 1311
Lithium-copper fluoride cells, wet stand characteristics; 1311
Lithium-copper fluoride dry tape cells; 1217
Lithium-copper fluoride-methyl formate cells; 1014
Lithium-copper sulfide cells; 871, 1168, 1239, 1386, 1802, 2166
Lithium corrosion in propylene carbonate; 1976
Lithium-cupric chloride battery; 1641
Lithium-cupric sulfide cells, 1775, 2035
Lithium-cupric sulfide cells, design analysis; 1260
Lithium-cuprous chloride battery; 1877
Lithium decomposition, acetonitrile; 1902
Lithium deposits in propylene carbonate; 1926
Lithium-dichloroisocyanuric acid cells; 1262, 1291
Lithium, dispersed, non-aqueous batteries; 1216
Lithium double layer capacity, effect of water; 1569
Lithium efficiency of deposition in propylene carbonate; 1565
Lithium, electrochemical behavior; 2180
Lithium electrodeposition, effects of substrate; 1122, 1131
Lithium electrodeposition, side-reactions; 1114

Lithium electrodes; 922, 923, 924, 926, 931, 934, 936, 937, 943, 946, 953, 954, 991, 1008, 1030, 1223, 1227, 1305, 1386, 1478
Lithium electrodes, activation; 1086
Lithium electrodes, alloys, 1375
Lithium electrodes, amalgamated; 1038, 1375
Lithium electrodes, capacitance studies; 1491
Lithium electrodes, composition; 1177
Lithium electrodes, copper sheet; 994
Lithium electrodes, cycling behavior; 1002, 1003, 1447
Lithium electrodes, dendrite formation; 1781
Lithium electrodes, design; 1089, 1905
Lithium electrodes, discharge characteristics; 1481
Lithium electrodes, dry tape batteries; 1072, 1291
Lithium electrodes, economics of use; 1006
Lithium electrodes, efficiency; 930, 932, 951, 1079, 1122, 1131
Lithium electrodes, encapsulation; 1291
Lithium electrodes, exchange current density; 1045, 1463, 1491
Lithium electrodes, fabrication; 942, 1032, 1042, 1787, 1925
Lithium electrodes, high temperature batteries; 1076
Lithium electrodes, impregnation techniques; 1089
Lithium electrodes, kinetics; 1327, 1491, 1989
Lithium electrodes, lithium-chlorine cells; 1018, 1237, 1246
Lithium electrodes, metal-air battery; 1447
Lithium electrodes, pasted structure; 925
Lithium electrodes, performance; 1278
Lithium electrodes, performance, effect of copper contact; 1797
Lithium electrodes, polarization; 926, 931, 939, 940, 941, 988, 992, 993, 1045, 1129, 1308, 1443, 1491, 1781, 1797, 1886, 1989, 2108, 2112
Lithium electrodes, polarization in lithium chloride; 1083
Lithium electrodes, polarization in propylene carbonate-aluminum chloride; 1481
Lithium electrodes, porous; 1375
Lithium electrodes, preparation; 951, 952, 961, 986, 990, 994, 1027, 1089, 1091, 1184, 1272, 1307, 1311, 1447, 1670, 1685
Lithium electrodes, pressure effects; 2111
Lithium electrodes, rechargeable; 1802
Lithium electrodes, reviews; 1085, 1087
Lithium electrodes, single pore; 1089
Lithium electrodes, stability in organic electrolytes; 1247
Lithium electrodes, surface area; 1089
Lithium electrodes, surface film formation; 1491, 1692
Lithium electrodes, thermal stability; 1797
Lithium electrodes, utilization; 939, 951, 1080, 1090, 1122, 1269, 1493, 1754, 2112
Lithium exchange current, effect of water; 1569
Lithium fluoride cells; 1103
Lithium fluoride, solubility in organic electrolytes; 1782
Lithium-fluorine primary cells; 416
Lithium glycolate; 1669

Lithium glycolate films; 1973
Lithium-graphite cells; 1897
Lithium-graphite-fluorine cells; 1121
Lithium halides, reactions in organic solvents; 1571
Lithium halides, solubility in organic solvents; 1228
Lithium hexafluoroaluminate, heat of formation; 1165
Lithium hexafluoroarsenate, preparation; 1810
Lithium hexafluoroarsenate solutes; 1795
Lithium hexafluorophosphate solutes; 1238, 1885
Lithium hexafluorophosphate, X-ray diffraction examination; 1091
Lithium hydroxide, electrolyte conductivity; 1148
Lithium hydroxide passivating films; 1021, 1224, 1288, 1912
Lithium iodide solutes; 1492
Lithium ion concentration, propylene carbonate; 1113, 1569
Lithium ion exchange cells; 1759
Lithium ion reaction, propylene carbonate; 1463
Lithium ion reduction; 2051
Lithium Leclanche' type cells; 1264
Lithium levulinate; 1903
Lithium levulinate depolarizer; 1925
Lithium/lithium chloride reversible potential; 1628
Lithium-magnesium alloy electrodes; 1217
Lithium-magnesium alloy electrodes, high temperature batteries; 1078
Lithium-magnesium alloy electrodes, liquid ammonia batteries; 1071
Lithium-manganese dioxide cells; 1000, 1103, 1104
Lithium-manganese oxide cells; 1036
Lithium-mercury fluoride cells; 1504
Lithium-metal chromate cells, design; 2189
Lithium-metal halides couples; 1519
Lithium, mineral deposits, availability; 1216
Lithium-moist air batteries; 1234, 1240, 1268, 1752
Lithium-molybdenum oxide battery; 2037
Lithium-nickel chloride cells; 1042, 1117
Lithium-nickel chloride cells, design; 1026
Lithium-nickel fluoride cells; 1042, 1184, 1211, 1760, 1848, 1849, 1903, 1925
Lithium-nickel fluoride cells, exchange, current densities; 975
Lithium-nickel fluoride cells, testing; 1307
Lithium-nickel halide cells, performance; 1215
Lithium-nickel sulfide cells; 1222, 1284, 1366
Lithium nickelate, formation; 1912
Lithium-organic nitrate cells, patents; 1814
Lithium-organic positive electrode battery; 1847
Lithium perchlorate; 2051
Lithium perchlorate, chromatographic analysis; 1288
Lithium perchlorate, conductivity in mixed solvents; 1483
Lithium perchlorate, conductivity in propylene glycol sulfite; 1669
Lithium perchlorate-dimethyl sulfite solutions; 1728, 1946, 2052
Lithium perchlorate electrolytes, maximum conductivity; 1020

Lithium perchlorate, explosion hazard; 967
Lithium perchlorate-propylene carbonate electrolyte; 1794
Lithium perchlorate, purification; 1241, 1245
Lithium perchlorate, solutes; 942, 959, 960, 1227, 1234, 1240, 1268, 1746, 1795
Lithium perchlorate, solvents, properties; 1728
Lithium perchlorate-tetrahydrofuran-dimethoxyethan electrolyte; 2035
Lithium-phosphorus/sulfur cells, design; 1779
Lithium-phosphorus/sulfur cells, performance; 1779
Lithium-platinum alloy formation; 1019, 1020, 1224, 1288
Lithium-polycarbon monofluoride battery; 2036
Lithium-polyquinone cells, patents; 1814
Lithium, properties in organic solvents; 1232
Lithium, reaction with organic solvents; 1107, 2039
Lithium reference electrodes; 1086
Lithium reference electrodes, dimethylsulfoxide; 1038
Lithium reference electrodes, preparation; 1037, 1313
Lithium reference electrodes, propylene carbonate; 1037
Lithium salts, viscosity characteristics; 1600
Lithium-selenium cells; 1691
Lithium-selenium cells, design; 1260, 1779
Lithium-selenium cells, implantable; 1779
Lithium-selenium cells, performance; 1779
Lithium-selenium/tellurium cells, performance; 1779
Lithium-silver cells, patents; 1814
Lithium-silver chloride cells, 871, 1117, 1272, 1443
Lithium-silver chloride cells, button-type; 1503
Lithium-silver chloride cells, design; 937, 942, 951, 952, 2109, 2111, 2113
Lithium-silver chloride cells, performance; 1503
Lithium-silver chloride cells, preparation; 1119
Lithium-silver fluoride cells; 1208
Lithium-silver oxide cells, 994, 1036, 1091
Lithium-silver sulfide cells; 2540, 1737
Lithium-silver sulfide cells, performance, effect of plate load; 1787
Lithium, solubility in lithium chlorine; 1923
Lithium, solubility in propylene carbonate; 1000, 1483
Lithium, stability in lithium perchlorate-propylene carbonate electrolyte; 1366
Lithium, stability in methyl formate electrolyte; 1483
Lithium, stability in organic electrolytes; 1091, 1184
Lithium, stability in organic solvents; 1103, 1104, 1166
Lithium, stability in organic sulfur compound solvents; 1236
Lithium, stability in perchlorate-propylene carbonate electrolytes; 1106
Lithium, stability in propylene carbonate; 1697
Lithium, stability in propylene carbonate-tetrahydrofuran; 1366
Lithium, stability in pure solvent; 1797
Lithium, sulfur cells; 1013, 1185, 1690, 1746
Lithium-sulfur cells, design; 1779
Lithium-sulfur cells, patents; 1814
Lithium-sulfur cells, performance; 1779, 2092

Lithium sulfur dioxide batteries; 1533, 1924, 2002
Lithium-tellurium cells, patents; 1814
Lithium tetrachloroaluminate solutes; 1877
Lithium tetrafluoroborate-dimethyl sulfite solutions; 1946
Lithium tetrafluoroborate, heat of formation; 1164
Lithium tetrafluoroborate, preparation; 1810
Lithium tetrafluoroborate solutes; 1238
Lithium-tetramethyl benzidine cells; 2002
Lithium thiocyanate electrodes; 1755
Lithium, transport numbers in butyrolactone; 1041, 1182
Lithium, transport numbers in propylene carbonate; 1119
Lithium, transport numbers in propylene carbonate-lithium perchlorate electrolytes; 1183
Lithium trifluoromethane-sulfonate solution; 1897
Lithium-tungsten cells, patents; 1814
Lithium-water complexes; 1224, 1288
Load cells; 870
Load programming; 883
Load simulators; 588
Load switching systems, automatic; 586
Low input voltage conversion; 1420
Low potential charging capacity; 648
Low temperature battery; 1533, 1657, 3085
Low temperature calcium batteries; 1212
Low temperature dry primary batteries; 4
Low temperature lithium batteries; 1116, 1851
Low temperature magnesium batteries; 1053, 1105
Low temperature non-aqueous cells; 2060
Low temperature operation, electrolyte behavior; 813
Low temperature organic electrolyte batteries; 643, 1212
Low temperature performance, cadmium electrodes; 760
Low temperature performance, calcium-silver chloride cells; 1212
Low temperature performance, magnesium perchlorate electrolyte battery; 1664
Low temperature performance, nickel-cadmium cells; 392, 442, 448, 477, 633, 908, 1219, 1458, 1476, 1682, 1683, 2184, 3410
Low temperature performance, nickel-zinc battery; 1665, 2064
Low temperature performance, primary cells; 462, 579, 643, 1178
Low temperature performance, secondary cells; 462, 579, 643, 1178
Low temperature performance, silver-cadmium cells; 2184
Low temperature performance, silver/silver oxide electrodes; 1674, 1916
Low temperature performance, silver-zinc cells; 423, 514, 595, 643, 1749
Low temperature performance, zinc-mercuric oxide cells; 643, 1192
Luggin capillary methods; 692, 780
Lunar Orbiter spacecraft power systems; 1554
Lunar Orbiter vehicle batteries; 529, 642
Lunar surface battery applications; 1836

M

Magnesium additions, silver oxide samples; 1593
Magnesium-air batteries, design; 1264
Magnesium-air batteries, low discharge efficiencies; 1355
Magnesium alloy electrodes; 849, 1357
Magnesium batteries, screening; 993
Magnesium-bismuth oxide dry cells; 7
Magnesium cells; 700
Magnesium-cuprous chloride cells; 7, 797
Magnesium-cuprous chloride primary reserve cells; 10, 64, 69, 80
Magnesium dry cells; 1358, 2140
Magnesium dry cells, flat, compared with round cells; 1506
Magnesium dry cells, patents; 1814
Magnesium dry cells, status; 1286, 2042, 2098
Magnesium electrodes; 2140
Magnesium electrodes, ammonia electrolytes; 1276, 1478
Magnesium electrodes, corrosion losses; 1105
Magnesium electrodes, dry tape aqueous batteries; 1217
Magnesium electrodes, efficiency; 1079, 1358
Magnesium electrodes, high temperature batteries; 1077, 1078
Magnesium electrodes, liquid ammonia batteries; 1105
Magnesium electrodes, liquid ammonia electrolytes; 1092, 1093
Magnesium electrodes, organic electrolytes; 943, 948, 949, 1030, 1223, 1305, 1386
Magnesium electrodes, polarization; 993
Magnesium-manganese dioxide dry cell batteries, characteristics; 1371
Magnesium-manganese dioxide dry cell batteries, compared with carbon zinc dry cells; 1371
Magnesium-manganese dioxide dry cells; 7, 463
Magnesium-manganese dioxide dry cells, mass production capability; 1649
Magnesium-manganese dioxide reserve batteries, evaluation; 1664, 2104, 2120
Magnesium-m-dinitrobenzene cells; 1358, 1506
Magnesium-mercuric oxide reserve batteries, evaluation; 1664
Magnesium-mercury sulfate cells; 1105
Magnesium-mercury sulfite cells; 1657
Magnesium-organic dry cells; 7
Magnesium-organic-N-halogen reserve cells; 7
Magnesium-oxygen cells, design; 1251
Magnesium perchlorate electrolytes; 1358
Magnesium-perchlorate electrolyte batteries; 1664, 2104, 2120
Magnesium perchlorate solutes; 1238
Magnesium, properties in organic solvents; 1232
Magnesium, reaction with organic solvents; 1107
Magnesium-refuellable primary batteries; 1264
Magnesium reserve batteries; 1963
Magnesium reserve electrodes; 356
Magnesium-silver chloride cells; 7, 979, 1012
Magnesium-vanadium oxide cells, patents; 1814

Magnetic resonance studies; 1907, 2049
Magnetite, effects on cadmium; 610
Magnetochemical analysis, nickel electrodes; 444
Maintenance, battery production equipment; 1649
Maintenance, definition; 605
Maintenance, frequency; 605
Maintenance, history; 605
Maintenance, procedures; 40, 248, 605, 892
Maleic anhydride additions, electrolytes; 231, 232, 518, 1486
Manganese additions, nickel; 200, 201, 270, 475, 1257
Manganese additions, silver-zinc cells; 1250
Manganese alkaline primary cells; 64, 166
Manganese alkaline secondary cells; 69, 166, 212
Manganese dioxide dry cells; 3
Manganese dioxide electrodes, organic electrolytes; 1079, 1080, 1328
Manganese electrodes, organic electrolytes; 983, 1305
Manganese-zinc cells; 799, 1440
Man-pack equipment batteries; 1573, 1641
Man-pack power sources; 1703
Manufacturers' information; 676, 677, 726, 797
Manufacturing specifications, spacecraft cells; 1516, 1517, 1518
Mariner spacecraft batteries; 670, 1399, 1838, 3006, 3046, 3173
Mass transfer (See Diffusion equation); 7820, 864
Mass transfer, electrochemical systems; 782, 1056, 1318, 1360, 1558, 1844, 1906, 3145, 3399
Mass transfer effects, lithium cells; 1586
Mass transfer, porous media; 1026, 1738
Mass transfer experiments, organic electrolytes; 1781
Mass transport experiments, organic electrolytes; 1058
Mass transport studies; 796, 3401
Mass transport studies, aluminum electrodes; 1643
Mass transport studies, metal-air batteries; 2025
Matched cell performance; 272, 556, 708
Measurements, electrical, failed cells; 1101
Measurements, non-performance; 915, 1101, 1220, 3135
Mechanical design, nickel-cadmium cells; 1646
Mechanical pressure, effects on cell voltage; 1736
Mechanical pressure, effects on sealing techniques; 1736
Mechanical properties, battery electrodes; 1432
Mechanical properties, nickel-cadmium battery electrodes; 1632
Mechanical space power systems; 1661
Mechanism models; 668
Membrane separators, conductivity; 1711
Membrane separators, gas permeability; 1711
Membrane separators, geometry; 1711
Membrane separators, pore distribution; 1711
Membrane separators, X-ray diffraction patterns; 1711
Membranes, absorption of potassium hydroxide; 731C
Membranes, anisotropic, properties; 1707

Membranes, Battery applications; 713
Membranes, beta-alumina; 2012
Membranes, commercial potentials; 713
Membranes, conductivity; 712, 749, 769, 2135, 2142
Membranes, copolymers; 781, 831, 1713, 1878
Membranes, copolymers, (ethylene and acrylic acid); 969, 1203
Membranes, electrical resistance; 738, 969, 1171, 1203
Membranes, electrolyte concentration; 731C, 1419
Membranes, fibrous, electrical resistance; 763
Membranes, grafted, characteristics; 466, 1720, 3384
Membranes, grafted, controls and tests; 1716
Membranes, grafted, preparation; 1716
Membranes, heat sterilized, characteristics; 888, 1137
Membranes, high temperature batteries; 1077, 1078
Membranes, hydrolysis, 969, 1203, 3236
Membranes, ion-exchange capacity; 1675
Membranes, microporous hydrophobic; 1601
Membranes, Organic; 1717
Membranes, permeability, 738, 1413, 1675, 1676, 1805, 1972, 2102, 2135, 2142, 3238
Membranes, pore size; 703, 1202, 1426, 3236
Membranes, porous; 1316, 3236, 3280
Membranes, potassium hydroxide (40 percent) at 135 F; 661
Membranes, resistance measurements; 1676
Membranes, resistivity, test methods, 781, 831
Membranes, separators; 694
Membranes, solute-binding; 1316
Membranes, solvents; 1316
Membranes, stability during sterilization; 969
Membranes, streaming potentials; 2102
Membranes, technology summary; 713, 3236
Membranes, tensile strength; 661, 1171
Membranes, thickness; 1316, 1675, 2102
Membranes, transport characteristics; 1202D, 1419, 1675, 1676, 1805, 1972, 2102, 2135, 2142
Membranes, vulcanized and hydrolyzed; 781
Membranes, vulcanizing methods; 965, 1203
Membranes, water content; 1675
Membranes, wet weight; 1675
Membranes, zeolites; 1077, 1078
Memory effects; 806, 844, 1463, 1727, 1922, 2026, 3155, 3371
Memory phenomena, cycling history of cells; 541, 3136, 3371
Mercuric oxide additions, zinc electrodes; 1293
Mercuric oxide-cadmium tape cells; 1282
Mercuric oxide cells, review; 1944
Mercuric oxide electrodes, efficiency, effects of pore size; 1192
Mercury additions, electrolytes; 228
Mercury additions, silver oxide samples; 1593
Mercury additions, zinc electrodes; 624, 635, 662, 1194, 1302, 1422, 1588, 2182
Mercury batteries; 885, 1304

Mercury batteries, characterization; 1605
Mercury-cadium cells; 1557
Mercury-carbon batteries, patents; 1814
Mercury cells; 913, 2061
Mercury cells, effects of storage temperature; 1737
Mercury cells, performance analysis; 1738
Mercury chloride electrodes, organic electrolytes; 1103
Mercury chloride, solubility in organic electrolytes; 1180
Mercury dry cells, status; 1286
Mercury electrodes, preparation; 1812
Mercury electrodes, pressed; 1901, 2141
Mercury electrodes, rechargeable; 1557
Mercury fluoride electrodes, preparation; 1504
Mercury fluoride, solubility in organic electrolytes; 1180
Mercury primary cells, 3, 4, 10, 64, 69, 113, 166, 797
Mercury, solubility in zinc; 2015
Mercury sulfate electrodes, organic electrolytes; 1103
Mercury sulfate electrodes, polarization; 1133
Mercury-zinc secondary cells; 101
Meta-dinitrobenzene, electrochemical reduction; 1605, 1606, 1897, 2140
Meta-dinitrobenzene electrodes; 1358, 2140
Meta-dinitrobenzene electrodes, polarization; 1133
Meta-dinitrobenzene electrodes, properties; 1276
Meta-dinitrobenzene, solubility in dimethylsulfoxide; 1577, 1897
Metal-air cells, review; 1355, 2098
Metal-carbon cells, patents; 1814
Metal fibers; 3216, 3217, 3409
Metal halide electrodes; 1214
Metal halide electrodes, electrode parameters; 1091
Metal halide electrodes, organic electrolytes; 1227, 1519
Metal halide electrodes, positive, review; 1556
Metal halide electrodes, reviews; 1027, 1085, 1087
Metal oxide additions, silver electrodes; 576
Metal oxide separators, hydrous; 1477
Metal-oxygen cells, design analysis; 1260
Metal-oxygen primary batteries; 1251
Metal-oxygen tape battery systems; 999
Metallic creep, estimation; 1173
Metallized-velvet fabrication; 1896
Metal sulfide electrodes; 1659
Metal thiocyanate electrodes; 1659
Metals, stability in dimethylformamide; 950
Metals, stability in organic electrolytes; 941, 943, 944, 945, 949, 951, 961
986, 991, 992, 993, 994, 1017, 1022, 1091, 1093
Meteorological balloon batteries; 669
Meteorological satellite spacecraft cells; 542
Methyl acetate electrolyte; 1851
Methyl acetate solvents; 960
Methyl chloroformate electrolytes; 1774
Methyl chloroformate-lithium aluminum chloride electrolytes; 1386
Methyl formate chromatographic analysis; 993

Methyl formate electrolyte; 1847, 1927
Methyl formate-lithium perchlorate electrolytes; 960
Methyl formate-perchlorate electrolytes; 1210, 1217, 1227, 1262, 1291
Methyl formate purification; 1483, 1810
Methyl formate solvents; 1227, 1278, 1295, 1483, 1795, 1926
Methylacetamide solvents, properties; 1231
Methylacetamide solvents, purification; 1231
Methylamine hydrochloride dry primary cells; 4
Methylene chloride electrolytes; 1848
Methylene chloride-propylene carbonate electrolytes; 1848
Methylformamide solvents; 1312
Methylformamide solvents, properties; 1231
Methylformamide solvents, purification; 1231
Methylsulfonates; 1742
Micro fuel cells, gas suppressors; 1290
Microprocessor, charge-discharge control; 3234
Microscopic observations, aluminum electrodes; 1671
Microscopic observations, battery application; 1756
Microscopic observations, dendrite growth; 746
Microscopic observations, lead electrodes; 2073
Microscopic observations, separators; 1666
Microscopic observations, silver electrodes; 1536, 1668, 1678, 1688
Microscopy, cadmium; 3378
Microscopy, nickel-cadmium cells; 3370
Microwave absorption, electrolytes and batteries; 918, 1657
Microwave absorption, equipment selection; 918
Microwave absorption, potassium hydroxide; 1667
Microwave studies, battery electrodes; 1667
Military equipment batteries; 913, 1335, 1664, 1875, 2042, 3131
Military specifications; 913, 914, 1499, 1500
Miners' Lamp batteries; 106
Missile batteries; 3, 207, 230, 423, 482, 506, 561
Missile batteries, reliability; 1213
Missile power supplies, high voltage; 732
Mobility, chloride ions in dimethyl sulfoxide; 1207
Mobility, lithium ions in dimethyl sulfoxide; 1207
Module evaluation, 95 volt batteries; 732
Module integration; 732A
Moisture distribution, fuel cell matrix; 1318, 1360, 1844
Molecular sieves, organic solvents; 1017
Molten electrolyte systems, patents; 1814
Molten halide electrolytes; 1425
Molten metal-cadmium mixtures; 665
Molten salt battery systems; 1425, 1578, 1671
Molybdenum backing plates, stabistors; 337
Molybdenum electrodes, organic electrolytes; 492, 981, 1305
Molybdenum trioxide electrodes, organic electrolytes; 1016, 2033
Monitoring, batteries; 708
Monoblock construction; 1251, 1601, 1626
Monoblock testing; 1336
Morpholittum hexafluorophosphate, conductivity in propylene glycol sulfite; 1669

Multichannel analyzers; 289

N

Negative alloy electrodes; 356
Negative electrode-electrolyte interactions; 871
Negative electrodes, design, water concept; 735
Negative electrodes, inorganic; 700
Negative electrodes, preparation; 849, 1110
Negative electrodes, shape change; 581, 635
Negative electrodes, soluble; 2002
Negative electrodes, sponge; 3154
Negative electrodes, studies; 903, 3050, 3052, 3140, 3396
Negative materials, studies, 651
Negative plates, material cycle tests; 646
Negative plates, pasted, performance; 793
Negative plates, preparation; 666, 860, 3213
Nickel acetate, impregnating solutions; 883
Nickel additions, cadmium electrodes; 1607, 1608
Nickel additions, silver oxide samples; 1593
Nickel aluminate, deposition on electrodes; 667
Nickel aluminate, electrode material; 1982
Nickel aluminide, dissolution; 1196
Nickel-cadmium batteries, aircraft charge control/conditioning system; 1623
Nickel-cadmium batteries, boosters for non-aqueous batteries; 1215
Nickel-cadmium batteries, characterization tests; 1816
Nickel-cadmium batteries, construction; 544, 858, 863, 1854, 3274
Nickel-cadmium batteries, design; 1971, 3232
Nickel-cadmium batteries, ground service; 885, 1354
Nickel-cadmium batteries, high rate; 1622, 1816, 1995
Nickel-cadmium batteries, life prediction; 803, 805, 911, 1747
Nickel-cadmium batteries, life prediction, space usage; 1349
Nickel-cadmium batteries, maintenance free; 1622, 1623, 1816, 1876
Nickel-cadmium batteries, OAO spacecraft; 3024, 3029, 3168, 3410
Nickel-cadmium batteries, OSO spacecraft; 1866
Nickel-cadmium batteries, patents; 1814
Nickel-cadmium batteries, performance and cost data; 875
Nickel-cadmium batteries, production processes; 375, 1733
Nickel-cadmium batteries, pulse applications; 1356
Nickel-cadmium batteries, sealed; 774, 818, 1069, 1367, 1876
Nickel-cadmium batteries, sealed, capacity ratings; 639, 649, 701, 706, 710, 716, 784, 793, 890, 963, 1108, 1149, 1150, 1151, 1254, 1285, 1433, 1434, 1435, 1436, 1496, 1497, 1498, 1513, 1622, 1650, 1655, 1736, 1753, 1758, 1898, 1899, 1900, 1941
Nickel-cadmium batteries, sealed, design and construction; 263, 1745, 3031, 3232
Nickel-cadmium batteries, sealed, developmental models; 1624, 3017
Nickel-cadmium batteries, sealed, electrical parameters; 635, 912
Nickel-cadmium batteries, sealed, miniature; 793
Nickel-cadmium batteries, sealed, rechargeable, military uses; 71

Nickel-cadmium batteries, separator evaluation; 1623
Nickel-cadmium batteries, service life, aircraft; 1619
Nickel-cadmium batteries, vented; 2, 10, 20, 43, 52, 64, 65, 73, 74, 75, 76,
118, 128, 136, 141, 162, 545, 577, 585, 587, 605, 616, 623, 1573, 1574,
1579, 1753, 1785, 1941, 2058, 2063, 3084, 3384
Nickel-cadmium batteries, vented, construction; 862
Nickel-cadmium battery, 2 kilowatt; 1744, 1973, 3099, 3100
Nickel-cadmium battery plates, construction; 1583
Nickel-cadmium battery plates, manufacturing survey; 1271
Nickel-cadmium cells, assembly for impacting and measuring forces on plates; 830
Nickel-cadmium cells, bibliographies; 27, 546, 3108
Nickel-cadmium cells, button-type; 2, 117
Nickel-cadmium cells, button-type, performance; 1683
Nickel-cadmium cells, calorimetric studies; 867, 1428
Nickel-cadmium cells, construction; 772
Nickel-cadmium cells, design; 4, 7, 17, 22, 23, 27, 29, 35, 36, 40, 44,
68, 69, 72, 77, 105, 106, 115, 118, 165, 191, 195, 222, 259, 271, 274,
292, 424, 489, 578, 846, 861, 877, 1402, 1554, 1645, 1744, 2046, 3107,
3017, 3052, 3053, 3072, 3274, 3361, 3363
Nickel-cadmium cells, design, cylindrical; 1454, 1631, 3274
Nickel-cadmium cells, design, prismatic; 1454, 1631
Nickel-cadmium cells, electrical characteristics; 1645, 1941, 2153, 3027, 3181
Nickel-cadmium cells, fabrication; 788, 919, 1140, 1627, 2007, 3031, 3380
Nickel-cadmium cells, formation; 1282
Nickel-cadmium cells, historical development; 772
Nickel-cadmium cells, laser applications; 1750
Nickel-cadmium cells, material selection; 1776, 3074, 3075, 3076, 3116
Nickel-cadmium cells, negative limited; 2065, 2077, 3031, 3050, 3052, 3061, 3062,
3063, 3064, 3065, 3113, 3114, 3140, 3342
Nickel-cadmium cells, nonferromagnetic electrode structures; 1998
Nickel-cadmium cells, open circuit stand; 1384
Nickel-cadmium cells, open, visual characteristics; 1496
Nickel-cadmium cells, optimum structural design, sealed, miniature; 1608
Nickel-cadmium cells, overcharge; 1384
Nickel-cadmium cells, oxygen recombination process; 1729
Nickel-cadmium cells, performance; 12, 22, 40, 54, 57, 67, 96, 107, 118, 121,
122, 135, 249, 265, 293, 387, 467, 473, 497, 539, 544, 613, 620, 630, 640,
1219, 1682, 1937, 3027, 3037, 3038, 3039, 3040, 3041, 3053, 3109, 3110,
3111, 3119, 3124, 3128, 3134, 3170, 3181, 3274, 3380, 3411, 3412
Nickel-cadmium cells, performance, effects of sterilization; 1454
Nickel-cadmium cells, performance, effects of storage; 534, 1496, 1497, 1777
Nickel-cadmium cells, performance, effects of temperature; 2, 121, 248, 364,
497, 1802, 1809, 1875
Nickel-cadmium cells, performance, limitations; 539
Nickel-cadmium cells, performance, predictions; 637, 3287
Nickel-cadmium cells, performance tests; 800, 1553, 1744, 1971
Nickel-cadmium cells, periodic complete discharge; 1384
Nickel-cadmium cells, physical characteristics; 1645, 1941
Nickel-cadmium cells, pocket plate; 726, 893, 907, 910
Nickel-cadmium cells, pressure changes; 2041, 3396
Nickel-cadmium cells, procurement and acceptance specifications; 1553
Nickel-cadmium cells, procedure for analysis; 3152

Nickel-cadmium cells, rapid charging; 1384, 3047, 3048
Nickel-cadmium cells, reviews; 772, 1294, 1729, 1944
Nickel-cadmium cells, sealed; 691, 829, 830, 896, 1100, 1341, 1644, 2000, 2095, 3084, 3371, 3377, 3396, 3398
Nickel-cadmium cells, sealed, capacity ratings; 828, 867, 1219, 1395, 1428, 1681, 1682, 1777, 1918, 1951, 1952, 1967
Nickel-cadmium cells, sealed, compared with silver-cadmium cells; 1347
Nickel-cadmium cells, sealed, design; 1258, 1393, 2021, 2116
Nickel-cadmium cells, sealed, design for safety; 2158
Nickel-cadmium cells, selection for portable instruments; 1864
Nickel-cadmium cells, selection for satellites; 1219, 3021, 3022, 3023, 3025, 3042, 3103, 3167, 3169
Nickel-cadmium cells, short tests; 717, 3201
Nickel-cadmium cells, sintered plate; 910, 1356, 1456, 3371
Nickel-cadmium cells, space application; 1528
Nickel-cadmium cells, spacecraft battery module; 1553, 3027, 3169
Nickel-cadmium cells, spacecraft requirements; 1553, 3020
Nickel-cadmium cells, state-of-the-art; 1344
Nickel-cadmium cells, temperature; 1384, 1918
Nickel-cadmium cells, three electrode cells; 606
Nickel-cadmium spacecraft batteries; 939, 664, 728, 1033
Nickel-cadmium spacecraft batteries, Apollo; 2041, 3240
Nickel-cadmium spacecraft batteries, design requirements; 1362, 1646, 1861
Nickel-cadmium spacecraft batteries, problems; 1281, 1729, 3390
Nickel-cadmium spacecraft batteries, Telstar; 17, 95, 293
Nickel-cadmium spacecraft cells, 6.0 ampere hour; 654, 3013
Nickel-cadmium spacecraft cells, 100 ampere hour; 3017, 3027, 3053, 3109, 3133
Nickel-cadmium squib batteries; 559, 729
Nickel carbonate impregnation; 1551
Nickel carbonyl powders; 575
Nickel chloride electrodes; 937
Nickel chloride electrodes, doped; 923, 1026, 1096
Nickel chloride electrodes, efficiency; 951
Nickel chloride electrodes, electroforced, polarization; 1026
Nickel chloride electrodes, organic; 1079
Nickel chloride electrodes, posted structure; 923, 1026
Nickel chloride electrodes, polarization; 922, 923, 924, 926
Nickel chloride electrodes, preparation; 923, 1307
Nickel chloride electrodes, solubility; 1597
Nickel chloride electrodes, utilization; 923, 940
Nickel-cobalt electrodes, preparation; 816
Nickel dissolution; 3194
Nickel, electrochemical behavior; 197, 201, 609
Nickel electrodes, activation; 427, 590, 1981, 1983
Nickel electrodes, additives, high potential; 2100
Nickel electrodes, anodization; 1196
Nickel electrodes, behavior variations; 730, 3393
Nickel electrodes, capacity loss; 1059
Nickel electrodes, capacity, theoretical; 1665
Nickel electrodes, carbonate and bicarbonate process; 1352
Nickel electrodes, charge acceptance; 1257
Nickel electrodes, charge-discharge reactions; 629, 772, 1346, 1993
Nickel electrodes, charged state development; 675

Nickel electrodes, coated; 1218
Nickel electrodes, coated with nickel aluminide; 1196
Nickel electrodes, coil; 861
Nickel electrodes, contamination by iron; 907
Nickel electrodes, cracking; 585
Nickel electrodes, crystal lattice; 2087
Nickel electrodes, cycling behavior; 197, 277
Nickel electrodes, decomposition in alkaline media; 2152, 3149
Nickel electrodes, degradation from sterilization; 733
Nickel electrodes, design; 200, 285, 286, 478, 3061, 3062, 3063, 3064, 3202
Nickel electrodes, doped; 626
Nickel electrodes, effects of additives; 1469, 2057, 2154
Nickel electrodes, effects of additives on charge reactions; 817
Nickel electrodes, effects of carbonate; 1973
Nickel electrodes, effects of composition; 183, 184, 185, 192, 200, 270
Nickel electrodes, effects of foreign ions; 327, 901
Nickel electrodes, effects of ozone; 2175, 2176
Nickel electrodes, electrochemical activity; 650, 668, 902, 1347, 2118
Nickel electrodes, electrochemical properties; 901, 3283, 3310
Nickel electrodes, electrodeposited; 1402
Nickel electrodes, fabric base, preparation; 1891
Nickel electrodes, fabrication; 915, 1377, 2122, 3267
Nickel electrodes, fibrous, preparation; 775, 1060
Nickel electrodes, flat plate; 299
Nickel electrodes, foil; 300, 1469, 1979, 1997
Nickel electrodes, honeycomb structure; 1945
Nickel electrodes, impregnation; 1981, 3130, 3311
Nickel electrodes, impregnation data; 1457
Nickel electrodes, impurities; 327
Nickel electrodes, irradiation effects; 671
Nickel electrodes, manufacturing processes; 565, 853, 1352, 1956, 3202, 3203, 3204, 3205
Nickel electrodes, organic electrolytes; 978, 992, 1001, 3149
Nickel electrodes, oxidation; 92, 2175, 2176, 3385
Nickel electrodes, passivation; 92, 270, 2152
Nickel electrodes, pasted; 1469, 1509, 1922
Nickel electrodes, physical characteristics; 1172
Nickel electrodes, plastic binder process; 1480
Nickel electrodes, plated graphite; 1060
Nickel electrodes, platinum catalyzed; 655
Nickel electrodes, polarization; 91, 124, 489, 840, 1273, 1274, 1275
Nickel electrodes, porosity; 59, 243
Nickel electrodes, positive; 557, 3394
Nickel electrodes, potential scan studies; 759, 3033
Nickel electrodes, potential step techniques; 1559
Nickel electrodes, preparation; 5, 6, 16, 18, 21, 23, 24, 55, 59, 70, 76, 77, 78, 79, 91, 110, 129, 131, 132, 143, 152, 154, 157, 165, 172, 178, 182, 189, 191, 214, 217, 219, 221, 224, 254, 270, 272, 277, 284, 361, 428, 469, 528, 532, 553, 575, 577, 585, 587, 667, 686, 696, 847, 873, 882, 904, 1058, 1143, 1340, 1395, 1423, 1552, 1620, 1829, 1937, 1983, 1999, 2004, 2018, 2065, 2100, 2147, 2154, 2155, 2181, 3130, 3180, 3202, 3203, 3204, 3205, 3304, 3306, 3311, 3322

Nickel electrodes, preparation, anodic oxidation; 1545
Nickel electrodes, preparation, anodic polarization; 882
Nickel electrodes, preparation, fused salt; 1889
Nickel electrodes, preparation, gold substrate; 1546
Nickel electrodes, preparation, process; 1551
Nickel electrodes, preparation, rolled; 509, 1854, 1979, 2066
Nickel electrodes, preparation, surface active agents; 1545, 1552
Nickel electrodes, pressed; 704, 1509, 1740, 3248, 3263, 3268, 3300
Nickel electrodes, reactions; 175, 288, 476
Nickel electrodes, reversible, preparation; 1196, 3394
Nickel electrodes, self discharge, effects of temperature; 727
Nickel electrodes, state-of-charge; 443
Nickel electrodes, strip, flexible; 1979
Nickel electrodes, structural changes; 444, 475, 479, 552, 675
Nickel electrodes, structure; 902
Nickel electrodes, support; 142, 143, 163, 2122, 3312
Nickel electrodes, Teflon film; 655, 844
Nickel electrodes, temperature coefficients; 1786
Nickel electrodes, thickness; 577, 587
Nickel electrodes, utilization; 1840, 2164
Nickel electrodes, vacuum impregnation; 1695, 1985
Nickel electrodes, X-ray diffraction studies; 201, 443, 540
Nickel flakes; 532, 863, 1931
Nickel fluoride, analyses; 973, 974, 975, 976, 977
Nickel fluoride, dehydration; 972, 974
Nickel fluoride, electrodes; 948, 971, 1103
Nickel fluoride, electrodes, analyses; 972, 1211
Nickel fluoride, electrodes, doped; 1096
Nickel fluoride, electrodes, evaluation; 1211
Nickel fluoride, electrodes, factorial testing; 975
Nickel fluoride, electrodes, organic electrolytes; 1079
Nickel fluoride, electrodes, pasted structure; 1026
Nickel fluoride, electrodes, polarization; 924, 977
Nickel fluoride, electrodes, pore size; 976, 977
Nickel fluoride, electrodes, porosity; 971, 976
Nickel fluoride, electrodes, positive; 1848, 1849
Nickel fluoride, electrodes, preparation; 972, 973, 974, 975, 977, 1211, 1307
Nickel fluoride, electrodes, structure; 1903
Nickel fluoride, electrodes, surface area; 971, 976, 977
Nickel fluoride, electrodes, utilization; 1096
Nickel fluoride, X-ray diffraction studies; 1384
Nickel foils, activation; 1997
Nickel foils, electroformed; 1945
Nickel formate, impregnating solutions; 882
Nickel grids, impregnation; 904, 1740
Nickel halide depolarizers, non-aqueous batteries; 1215
Nickel hydrate composites; 3180
Nickel hydrogen battery; 3005, 3008, 3408
Nickel hydroxide additions, cadmium electrodes; 318, 3256, 3384
Nickel hydroxide, cathodic precipitation; 1469
Nickel hydroxide, crystallography; 200, 201, 270, 2162

Nickel hydroxide electrodes, cadmium additions; 2015
Nickel hydroxide electrodes, cobalt additions; 2019, 3155, 3158
Nickel hydroxide electrodes, electrochemical activity in alkali hydroxides; 1594, 1871
Nickel hydroxide electrodes, electrochemical behavior; 1993, 2026, 2151, 3247, 3371
Nickel hydroxide electrodes, electrochemical impregnation; 3302
Nickel hydroxide electrodes, impregnation at elevated temperature; 1695, 2107, 3087
Nickel hydroxide electrodes, iron impurity; 3182
Nickel hydroxide electrodes, oxidation; 270, 1928
Nickel hydroxide electrodes, pasted; 3206
Nickel hydroxide electrodes, preparation; 192, 2099, 3126, 3155, 3157, 3183, 3209, 3303, 3318, 3319
Nickel hydroxide electrodes, thermogravimetric studies; 902, 1928
Nickel hydroxide electrodes, water content; 902, 1589, 1928, 3176, 3177, 3184
Nickel hydroxide, electrolytic preparation; 1962
Nickel hydroxide, heat of formation; 650
Nickel hydroxide, precipitation; 686
Nickel hydroxide, precipitation, constant potential; 1552
Nickel hydroxide, precipitation, elevated temperature; 1552
Nickel hydroxide, preparation; 834
Nickel hydroxide, stoichiometry; 444, 675
Nickel hydroxide, structures; 90, 3054, 3147
Nickel hydroxide, thermal decomposition; 902
Nickel-iron alloys, polarization in acid solutions; 594
Nickel-iron batteries; 881
Nickel-iron batteries, construction; 558
Nickel-iron batteries, evaluations; 1292, 1364, 1544
Nickel-iron batteries, patents; 1814
Nickel-iron powder sintered bodies; 147
Nickel-iron secondary cells (Edison cells); 4, 7, 10, 31, 64, 65, 68, 105, 106, 125, 126, 134, 136, 142, 143, 161, 178, 264, 290, 851, 3391
Nickel matrix, foam; 2099
Nickel matrix, pore structure; 447
Nickel matrix, preparation; 298, 1509
Nickel nitrate, thermal decomposition; 426
Nickel nitrate, vacuum decomposition; 1985
Nickel oxide electrodes; 127, 481, 607, 3244, 3252, 3253, 3254, 3277, 3278, 3285, 3286, 3298, 3308, 3309, 3310, 3313, 3324
Nickel oxide electrodes, absorption studies; 56
Nickel oxide electrodes, aging effects; 1275
Nickel oxide electrodes, capacity loss, 878
Nickel oxide electrodes, cermet; 3243, 3257, 3260, 3261, 3314
Nickel oxide electrodes, charge-discharge processes; 55, 1273, 3252, 3305, 3313
Nickel oxide electrodes, chemical analysis; 1274
Nickel oxide electrodes, impregnation techniques; 802, 3324
Nickel oxide electrodes, lithiated; 3187, 3193, 3199, 3290
Nickel oxide electrodes, mechanism for loss of charge; 705
Nickel oxide electrodes, organic electrolytes; 492, 978, 979, 1103
Nickel oxide electrodes, physical characteristics; 1273, 3285, 3321
Nickel oxide electrodes, preparation; 602, 608, 669, 3151, 3266
Nickel oxide electrodes, preparation, electro-deposition; 686, 1273, 1427, 1695, 1997
Nickel oxide electrodes, swelling; 838

Nickel oxides; 176, 281, 286, 443, 445, 475, 476, 3350
Nickel oxides, chemisorption of oxygen; 1694
Nickel oxides, crystallography; 243, 475
Nickel oxides, decomposition; 175
Nickel oxides, formation of vacancies; 1694
Nickel oxides, stability; 705
Nickel oxides, stability in potassium hydroxide; 1274, 3151
Nickel oxides, structure; 475, 705, 3285
Nickel oxide transport properties; 3328, 3329
Nickel plaques, anodic polarization in alkaline nickel-ammine solutions; 882
Nickel plaques, anodic polarization in sodium bicarbonate solutions; 906
Nickel plaques, compaction technique; 2091
Nickel plaques, corrosion; 1840, 1977
Nickel plaques, development; 821, 1451
Nickel plaques, drying operation studies; 1660
Nickel plaques, electrical resistivity; 1322, 1408, 1465
Nickel plaques, electrochemical cleaning; 1451, 1978, 2018
Nickel plaques, fabrication; 1271, 1455, 1465, 1945, 1978, 2004, 2091, 2115, 3264
Nickel plaques, fiber, physical properties; 438, 1451, 1937
Nickel plaques, impregnation; 686, 882, 905, 908, 916, 1366, 1451, 1539, 1776, 1840, 1948, 1949, 1978, 2004, 3141, 3383
Nickel plaques, impregnation with active materials; 1271, 1761, 1828, 1829, 3141
Nickel plaques, impregnation with cadmium; 1890
Nickel plaques, impregnation, cathodic; 1552
Nickel plaques, impregnation, chemical conversion process; 1840, 1977
Nickel plaques, impregnation, electrochemical process; 2055, 3141
Nickel plaques, impregnation with active materials; 1271, 1761, 1828, 1829, 3141
Nickel plaques, impregnation with cadmium; 1890
Nickel plaques, impregnation, cathodic; 1552
Nickel plaques, impregnation, chemical conversion process; 1840, 1977
Nickel plaques, impregnation, electrochemical process; 2055, 3141
Nickel plaques, impregnation, single cycle; 882
Nickel plaques, impregnation, single step; 882, 1890
Nickel plaques, large internal surface area; 821
Nickel plaques, manufacturing processes; 1956, 3291
Nickel plaques, mechanical strength; 1408, 1948, 1949
Nickel plaques, metallographic examination; 1322, 1408, 1451
Nickel plaques, microscopic characterization; 1270
Nickel plaques, pore size; 1451
Nickel plaques, pore size distribution; 1322
Nickel plaques, pore volume determination; 1451
Nickel plaques, porosity; 243, 1408, 1465, 1660, 1733, 1948, 1949, 2065
Nickel plaques, preparation; 180, 273, 445, 447, 469, 840, 845, 906, 1070, 1142, 1322, 2149, 3301
Nickel plaques, preselected pore size; 821
Nickel plaques, reproducible; 1408, 1776, 1977
Nickel plaques, resistivity; 1948, 1949
Nickel plaques, shrinkage; 1408
Nickel plaques, sintering; 1322, 1457, 2149, 3291
Nickel plaques, sintering process; 840, 1271, 1408, 1465, 1733, 1948, 1949, 3264, 3265
Nickel plaques, sintering process controls; 1846, 1978
Nickel plaques, slurry coating techniques; 1416, 1539, 3291
Nickel plaques, strength; 1733
Nickel plaques, surface area measurements; 272, 1322, 1408, 1840

Nickel plaques, swelling; 2162
Nickel plaques, thickness; 1408, 1733, 2162
Nickel plaques, uniformity; 1416, 1539, 1733, 1776, 1977
Nickel plaques, utilization factors; 1948
Nickel plaques, weights; 1408, 1451, 1733
Nickel-plated electrodes; 528
Nickel plates, characterization; 1539, 3242
Nickel plates, charge efficiency; 793
Nickel plates, chemical analysis; 1776, 1977
Nickel plates, design data; 1665
Nickel plates, fabrication; 916, 1872, 1931
Nickel plates, material conversion; 1856
Nickel plates, porosity; 919, 1872
Nickel plates, porous, production; 776, 1872
Nickel plates, positive, fabrication; 1761
Nickel plates, saturation, cadmium and nickel salt solutions; 3279
Nickel plates, sterilization effects; 1051
Nickel plates, weight/capacity correlation; 1700
Nickel plates, woven cotton cloth; 1872
Nickel powders; 552, 608
Nickel powders, analysis; 180, 3381
Nickel powders, characterization of particle size; 1270
Nickel powders, electrolytic production; 1615, 1984
Nickel powders, high surface area; 1615, 1984, 3381
Nickel powders, physical characteristics; 1271, 1539, 1949, 1977, 2147, 3381
Nickel powders, uniformity; 1539, 3381
Nickel-silver cells; 1533
Nickel sinter; 557
Nickel solutions, nickel formate or acetate; 882
Nickel solutions, preparation of ammine impregnating solutions; 882
Nickel sulfide electrodes, cathodic discharge; 1392
Nickel sulfide electrodes, efficiency; 1222, 1284
Nickel sulfide electrodes, polarization; 1886
Nickel sulfide, solubility in propylene carbonate-perchlorate electrolytes; 1222, 1366, 1392
Nickel systems, organic electrolytes; 1305
Nickel tetracarbonyl, recovery; 611
Nickel thiocyanate electrodes; 2043, 2078
Nickel-wool electrode matrices; 1334, 1339
Nickel-zinc batteries; 4, 596
Nickel-zinc batteries, construction; 858
Nickel-zinc batteries, evaluation; 1292, 1364, 1544
Nickel-zinc batteries, rechargeable; 2066
Nickel-zinc batteries, secondary; 695, 1592, 1880, 1892, 1893, 2064, 2098
Nickel-zinc batteries, secondary, development; 1665
Nickel-zinc cells; 596, 751, 789, 878, 1052, 1066, 1218, 1303
Nickel-zinc cells, electrode migration; 596
Nickelic hydrexide, preparation; 592, 1480
Nimbus spacecraft power systems; 1553, 3111
Nitrate additions, electrolytes; 130
Nitrate contamination, nickel-cadmium cells; 130, 327, 1956, 3002
Nitrate ion reduction, cadmium electrode; 3270
Nitrate ions, voltage pulse catalysis; 1095

Nitrate, reduction in alkaline solutions; 1934
Nitrate, removal; 904, 1999, 2149, 2165
Nitrate, removal, nickel plaques; 2149
Nitrate, solutes, sulfur-containing organic electrolytes; 1168
Nitroaromatic cathode depolarizers; 1267
Nitroaromatic compounds, reduction mechanism; 1267
Nitrogen compounds as organic depolarizers; 1075
Nitromethane; 1599
Nitromethane-hexafluorophosphate electrolytes; 939, 973
Nitromethane-lithium-aluminum chloride electrolytes; 961, 1272
Nitromethane-propylene carbonate-aluminum chloride electrolytes; 1177
Nitromethane-propylene carbonate electrolyte; 1534, 1850
Nitromethane solvents; 1278
Nitromethane solvents, properties; 971, 1272
Nitromethane solvents, voltage stability; 1604
Nitrosodimethylamine-lithium thiocyanate electrolyte; 1754
Nitrosodimethylamine solvents; 946, 1091, 1234, 1240, 1752
Nitrosodimethylamine solvents, conductivity measurements; 1268
Nitrosodimethylamine, water removal; 1088
N-methyl pyrrolidinone, organic solvents; 1926
N-methyl-2-pyrrolidone; 1542
N-methyl-2-pyrrolidone-morpholinium hexafluorophosphate electrolytes; 976
N-methyl-2-pyrrolidone-phenyltrimethyl-ammonium hexafluorophosphate electrolytes; 976
N-methyl-2-pyrrolidone solvents, properties; 971
N-methyl-2-pyrrolidone solvents, purification; 971
N-methyl-2-pyrrolidone-tetramethyl-ammonium hexafluorophosphate electrolytes; 976
N-methylformamide solvents, physical properties (25 C); 1485
Non-aqueous electrolyte batteries; 643, 1577, 1754, 1757, 2052, 2166, 2188
Non-aqueous electrolyte batteries, analysis; 1450
Non-aqueous electrolyte studies; 1606, 1946, 2051
Non-aqueous solutions, composition; 1543
Non-aqueous solutions, review; 1604
Non-destructive testing; 466, 3178
Non-woven polyamides; 556
Nuclear energy sources, bibliography; 965
Nuclear magnetic resonance analysis, organic electrolytes; 967
Nuclear magnetic resonance studies, organic electrolytes; 985, 1023, 1024, 1543, 1584
Nuclear primary cells; 4, 7
Nuclear space power systems; 1661
Null-balance servo systems; 339
Nylon coating, aluminum cell cases; 1208, 1209
Nylon separators; 385, 585, 587
Nylon separators, nickel-cadmium cells, test results; 1758, 3123
Nylon woven separators; 626

0

OGO orbiting vehicle flight data; 471, 472
OGO spacecraft battery study; 1610
OGO spacecraft electrical power system; 471, 472
Ohmic resistance, nickel-cadmium cells; 46, 198, 377
Open circuit potentials, organic half-cells; 1098
Open circuit stand tests, silver-cadmium cells; 1732
Operating characteristics; 693
Operating instructions, battery production equipment; 1649
Operation position tests; 595
Operation schedules; 621
Optical methods, battery application; 1756, 3009, 3147
Optical studies, zinc corrosion films; 535
Optimization; 1662
Optimization investigations, battery subsystem; 1501
Optimization investigations, silver-zinc cells; 207, 213
Optimization investigations, zinc-oxygen cells; 523
Orbital histories; 202, 461, 470, 471, 499, 698, 1108, 1884
Orbital life tests, simulated; 1220, 1377, 1601, 1627, 2007, 2084, 3090
Organic batteries, hardware; 1307
Organic components, effects on cell capacity; 1293, 1422, 1588
Organic components, sealants; 1422
Organic compounds, addition to electrolytes; 646
Organic compounds, addition to potassium hydroxide electrolytes; 1068
Organic compounds, chronopotentiometric investigations; 1450
Organic compounds, effects on cell capacity, after sterilization; 1363
Organic compounds, effects on silver-zinc cells; 888
Organic depolarized cells; 64
Organic electrodes; 962, 1103, 1190, 1238, 1262, 1291
Organic electrodes, discharge efficiencies; 1321
Organic electrodes, dry tape batteries; 995, 996, 999
Organic electrodes, liquid ammonia batteries; 1071
Organic electrodes, materials; 991, 992, 993, 1016, 1072, 1075, 1091, 1267
Organic electrodes, physical data; 1757
Organic electrodes, positive; 1914
Organic electrodes, rechargeable; 1943
Organic electrolyte additives, effects on performance; 1245
Organic electrolyte batteries; 368, 700, 1641, 1943
Organic electrolyte batteries, design; 1227, 1242, 1394, 1947, 2050, 2189
Organic electrolyte batteries, patent review; 1659
Organic electrolyte batteries, reviews; 1191, 1310, 2098
Organic electrolyte cells, screening; 1095
Organic electrolyte systems, patents; 1814
Organic electrolytes, analyses; 962, 967, 978, 983, 985, 988, 1295
Organic electrolytes, analyses by nuclear magnetic resonance; 1023, 1024
Organic electrolytes, anion solvation; 1542
Organic electrolytes, bibliography; 956

Organic electrolytes, cation solvation; 1542
Organic electrolytes containing sulfur; 1010, 1090, 1111, 1168
Organic electrolytes, contamination; 25, 930, 933, 934, 940
Organic electrolytes, double layer capacitance; 1127
Organic electrolytes, electrocapillarity curves; 1127
Organic electrolytes, encapsulation; 1072
Organic electrolytes, general requirements; 1307
Organic electrolytes, impurities; 1295
Organic electrolytes, low temperature; 1505
Organic electrolytes, patents; 1760
Organic electrolytes, preparation; 985, 1024
Organic electrolytes, properties; 945, 946, 947, 948, 949, 950, 967, 984, 983, 1000, 1024, 1029, 1085, 1086, 1090, 1120, 1295
Organic electrolytes, properties, physical; 1542
Organic electrolytes, purification; 492, 922, 928, 929, 930, 931, 944, 978, 979, 983, 1001
Organic electrolytes, purity; 962
Organic electrolytes, reviews; 1027, 1085, 1087, 1243
Organic electrolytes, screening; 925, 945, 946, 948, 950, 978, 979, 980, 981, 982, 986, 990, 1016, 1017, 1022, 1024, 1030, 1036, 1081, 1093, 1095, 1098, 1351
Organic electrolytes, stability; 1190
Organic electrolytes, structural studies; 1295
Organic electrolytes, thermal stability; 1284
Organic materials, adsorption on zinc electrodes; 731B, 1426B
Organic-metal reactions, bibliography; 956
Organic nitrate electrodes; 1478
Organic nitro-compounds, electroreduction products; 1577
Organic residues, presence in cell electrolyte; 1770
Organic residues, silver electrodes; 692, 833
Organic solvents, acid-base behavior; 1342
Organic solvents, analyses; 984, 1007
Organic solvents, classification; 1342
Organic solvents, containing sulfur; 1111
Organic solvents, contamination, effects on cell efficiency; 1019
Organic solvents, decomposition; 1017
Organic solvents, electrode kinetics; 2038
Organic solvents, lithium battery electrolytes; 1586
Organic solvents, metal complexes; 1604
Organic solvents, properties; 943, 1017, 1023, 1075, 1133, 1184, 1245, 1852
Organic solvents, properties, review; 1397
Organic solvents, properties, techniques of measurement; 1230
Organic solvents, purification; 983, 1002, 1003, 1007, 1023, 1295, 1501
Organic solvents, purification, review; 1397
Organic solvents, review; 1243
Organic solvents, screening; 1074, 1075, 1080, 1669
Organic solvents, selection for lithium batteries; 1802
Organic solvents, stability on electrolysis; 1017
Organic solvents, voltammetry, screening tests; 1026

Organic solvents, water content; 1023
Organic solvents, water extraction; 927
Organic sulfur compound solvents, screening; 1236
Oscillators, loop; 609
Oscillographic studies; 609
Oscilloscopes, pulse techniques; 377
Osmotic coefficients, organic electrolytes containing chlorides; 1163
Osmotic coefficients, organic electrolytes containing perchlorates; 1163
Output capacity, variations with current; 734
Output capacity, variations with temperature; 734
Output, decreased; 551
Output, improvement; 551
Output, voltage, standardization; 1703
Overcharge capability, nickel-cadmium cells; 89, 95, 104, 193, 442, 467, 1680
Overcharge characteristics, nickel-cadmium cells; 203, 333, 358, 483, 542, 626, 633, 1841, 1842, 2020
Overcharge characteristics, nickel oxide electrodes; 183, 184, 185
Overcharge, continuous; 8, 95, 186, 188, 475
Overcharge, control; 1151
Overcharge, equilibrium; 649
Overcharge, low temperature; 1799
Overcharge, maximum rate; 459
Overcharge, mechanisms; 61, 94, 102, 3226
Overcharge, protection; 706, 963, 1062, 1938
Overcharge, reactions, lead-acid batteries; 1766
Overdischarge protection; 483, 706, 963, 3137, 3389
Overload protection; 586
Overpotential; 243, 518, 549, 3353, 3368, 3399, 3406
Overpotential, cut-off relays; 613
Overvoltage studies, electrode support materials; 888
Oxidation-reduction materials, organic solvents; 1604
Oxide layers, formation on zinc; 744
Oxides, additions to electrodes; 363
Oxides, composite electrodes; 425
Oxides, formation on nickel; 609, 1346, 3197
Oxides, formation on silver; 521
Oxygen absorption rates; 783, 823, 889
Oxygen activity sites; 552
Oxygen adsorption, silver electrodes; 485
Oxygen consuming electrodes; 1824, 3394
Oxygen consumption, cadmium electrodes; 818, 1252, 1680
Oxygen consumption rates, cadmium plates; 42
Oxygen consumption rates, sealed cells; 58, 275
Oxygen consumption rates, zinc plates; 1250
Oxygen determination, organic media; 1234
Oxygen diffusion, potassium hydroxide; 459
Oxygen discharge; 3077
Oxygen electrodes, deterioration; 920
Oxygen electrodes, fixed zone; 523, 694, 820, 1296, 1297, 1343, 1663
Oxygen electrodes, fuel cell type; 434, 508

Oxygen electrodes, materials; 606, 3150
Oxygen electrodes, organic electrolytes; 1234, 1240, 1265, 1268
Oxygen electrodes, polarization; 706, 920
Oxygen electrodes, reaction mechanisms; 2145
Oxygen electrodes, recombination; 440, 508, 510, 619, 655, 829, 844, 894, 1258, 1333, 1379, 1429, 1858
Oxygen electrodes, sensing; 440, 510, 655, 844, 1258, 1333, 1817, 1818
Oxygen electrodes, utilization in cell scaling device; 1701
Oxygen evolution, control; 859
Oxygen evolution, nickel-cadmium batteries; 61, 355, 556, 607
Oxygen evolution, nickel electrodes; 481, 609, 3298
Oxygen evolution, nickel hydroxide electrodes; 1589
Oxygen evolution, potentials, nickel oxide; 1274
Oxygen evolution, rates; 730
Oxygen evolution, rates, monitoring; 755
Oxygen evolution and recombination; 772
Oxygen evolution, sealed cells; 1257
Oxygen evolution, silver-cadmium cells; 275
Oxygen evolution, silver-zinc batteries; 624
Oxygen evolution, theory, 626
Oxygen formation, prevention; 756
Oxygen generation, cadmium in potassium hydroxide; 282
Oxygen-hydrogen recombination; 1258
Oxygen monitoring equipment; 730
Oxygen overvoltage, lead electrodes; 1811
Oxygen partial pressure; 194, 606, 3395
Oxygen pressure, effects on nickel-cadmium cells; 42
Oxygen pressure on overcharge; 94
Oxygen recombination; 107, 109, 756, 908
Oxygen recombination rates; 94, 495, 716, 894, 896, 1250, 2021, 3389
Oxygen reduction, cadmium electrodes; 84, 332, 1598, 1843, 3246, 3281, 3308, 3386
Oxygen reduction, limiting current on cadmium electrodes; 1598
Oxygen reduction mechanisms; 63, 84, 246
Oxygen reduction, non-aqueous media; 1752, 3149
Oxygen reduction, zinc electrodes; 1250
Oxygen removal, nickel oxide electrodes; 481
Oxygen transport mechanisms; 85
Oxygen reduction, nickel electrode; 3385

P

Package design; 644, 1290
Package design, silver-zinc cells; 1388
Palladium additions, battery case; 1745
Palladium additions, nickel electrodes; 123, 238, 623
Palladium additions, separators; 396
Palladium additions, silver; 238, 502, 515, 580, 583, 624, 672, 1429
Palladium additions, silver oxide samples; 1593
Palladium additions, zinc electrodes; 2144

Palladium-alumina additions, zinc; 502
Palladium-capped cell openings, 569
Palladium-rhodium alloys, lead-acid cells; 295
Palladium-silver alloys; 802
Palladium-silver positives; 408, 1250
Passivation studies (See Specific metals)
Paste electrolytes, lithium cells; 1779
Peak current tests; 595
Pentachloride solutes; 924
2-4-pentanedione solvents; 1329
2-pentanone solvents; 1329
Perchlorate ions, voltage pulse catalysis; 1095
Perchlorate solutes; 927, 930, 932, 937, 990, 1000, 1011, 1029, 1086, 1090, 1155, 1248, 1329
Perchlorate solutes, concentration, effects on cell performance; 1014
Perchlorate solutes, effects on solubility of copper fluoride; 987
Perchlorate solutes, sulfur-containing organic electrolytes; 1168
Performance, figure of merit; 1087
Performance, improvement through technical advances; 1349
Performance, measuring devices; 685, 3031, 3032
Performance, parameters; 1213, 3101
Performance, prediction; 211, 1349, 3142
Performance, sterilized sealed cells; 866, 1363, 3070
Permanganate additions, silver electrodes; 1789
Permanganate coefficients; 2142
Permeability, hydraulic, of separators; 879, 2102
Permeability, silver oxides; 581
Phase diagram organic solvent water systems; 1505
Phase shift measurements, nickel-cadmium cells, 46, 98, 198, 398, 1987
Phenolphthalein leak tests; 717
Phenyltrimethylammonium hexafluorophosphate solutes; 1234, 1240, 1268
Phenyltrimethylammonium hexafluorophosphate solvents; 1752
Phosphate additions, alkaline electrolytes; 1407
Phosphate depolarized cells; 880
Phosphate solutes, sulfur-containing organic electrolytes; 1168
Photo-micrography studies, electrodes; 540
Photovoltaic power systems; 1662
Pioneer spacecraft batteries; 335
Plaques, fabrication; 899, 3103, 3222, 3382, 3409
Plaques, fiber; 438, 1451, 1937, 3382
Plaques, honeycomb structure; 1800
Plaques, loading, positive; 2118, 3096, 3218
Plaques, loading techniques; 1937, 2021, 3103, 3218
Plaques, porous, impregnation; 703, 1761, 3381
Plaques, preparation, rolled; 1352
Plaques, preparation, sintered; 2107, 3096, 3381
Plaques, weight variation measurements; 1773
Plastic electrodes; 49
Plastic welding, hot gas; 597

Plastics, electrochemical compatibility; 1770, 302
Plastics, engineering properties; 1785, 3026
Plastics, stability in organic electrolytes; 941, 943, 991, 1093, 3026
Platelock system development; 1336
Plates, compression; 1457
Plates, density studies; 645
Plates, effect of sintering atmospheres; 1635, 3074
Plates, electrolytic etching; 1772
Plates, intercellular connectors; 1825
Plates, manufacturing processes; 1799, 3095, 3088, 3096, 3097, 3211, 3212, 3223, 3381
Plates, nickel, thin. preparation; 809, 3096
Plates, nitrate retention; 1934
Plates, reinforcing materials; 888
Plates, rolled; 509, 1772
Plates, sintered, surface area; 1635, 3054
Plates, thickness, effects of; 1456, 1457, 1458
Plates, thin; 911
Plates, under constant pressure; 784
Platinum auxiliary electrodes; 334
Platinum electrodes, gold plated; 607
Platinum electrodes, liquid ammonia batteries; 1093
Platinum electrodes, reaction in non-aqueous media; 1752
Platinum recombination catalysts; 574
Plitt seals, nickel-cadmium cells; 507
Polar orbit, simulated; 1100
Polarons; 3328, 3329
Polarization, activation; 802
Polarization, anodic, porous nickel in ammine solutions; 882
Polarization, anodic, in potassium hydroxide; 742
Polarization, cadmium electrode; 1376
Polarization, cathodic, in potassium hydroxide; 742
Polarization, cathodic step in preparation; 882
Polarization, concentration; 802
Polarization, curves; 881, 2031
Polarization, heat effects relationships; 548
Polarization, lithium-chlorine cells; 1237, 1976
Polarization, lithium-nickel fluoride cells; 974, 975
Polarization, lithium-nickel sulfide cells; 1366
Polarization measurements, silver electrodes; 780, 2110
Polarization studies; 898, 1976, 3074, 3075, 3076, 3376, 3395, 3402, 2405
Polarization studies, metal-air batteries; 2025
Polarization studies, zinc electrodes; 865, 1099, 1139, 1141, 1226
Polarizations, anode and cathode, nickel-cadmium; 802
Polarographic apparatus; 607
Polarographic reduction; 2051
Polarographic study, cadmium complexes; 3356
Polarographic studies, zinc complexes; 1193
Polarography (See also Voltammetry); 1096
Polarography, organic electrolytes; 931, 933, 934, 935, 938, 1852
Polybenzimidazole, bonding techniques; 884
Polybenzimidazole, compression molded, physical properties; 884

Polyethylene films, crosslinking; 764, 1400, 1716, 1720, 1940
Polyethylene films grafting; 764, 1361, 1400, 1414, 1716, 1720, 1940
Polyethylene films irradiated; 7310
Polyethylene films, properties; 1720, 1735
Polyethylene glycol additions, cadmium electrodes; 585
Polyethylene glycol electrolytes; 4
Polyethylenes; 555, 563
Polymer membranes; 711, 836, 1171, 1316
Polypropylene separators, absorption of potassium hydroxide; 1140
Polypropylene separators, evaluation; 919
Polypropylene separators, nickel-cadmium cells, test results; 1758
Polypropylene separators, organic electrolyte batteries; 1493
Polypropylene separators, organic electrolytes; 1042
Polystyrene sponge; 572
Polysulfide formation rate, during charging; 1787
Polysulfide reaction products; 1185
Polytetrafluoroethylene additions, zinc electrodes; 1771
Polyvinyl alcohol additions, zinc electrodes; 502
Polyvinyl quinone electrodes, preparation; 1394
Polyvinyl separators, 137, 151, 451
Polyvinylchloride separators, organic electrolytes; 961
Pore-formers, 704, 840, 2088
Pore size distribution, electrodes; 919, 3379
Pore size distribution, nickel plates, 916, 2115, 3030, 3321
Pore size, dual distribution, 855
Pore size geometry; 1471, 1521, 1945, 2115, 3068, 3092
Pore size, nickel fluoride electrodes; 971, 976, 977, 1184
Pores, current distribution; 1288
Porosity, determinations; 1070, 3030, 3096, 3148, 3164, 3186, 3242, 3321, 3382
Porosity, high, nickel carbonyl; 575
Porosity, low, frit; 575
Porous electrodes; 3185, 3357, 3399, 3405
Positive electrode-electrolyte interactions; 871
Positive electrodes; 556, 578, 2053, 3383
Positive electrodes, inorganic; 700, 2043
Positive electrodes, organic; 700
Positive electrodes, stability of active material; 1345
Positive electrodes, storage in electrolytes; 730
Positive to negative ratio, nickel-cadmium batteries; 1206
Positive plate growth, lead-calcium batteries; 1206
Potassium acid sulfate, electrolyte; 1963
Potassium amalgam electrodes, discharge capacity; 1330, 1423
Potassium amalgam electrodes, electrochemical studies; 1633
Potassium amalgam electrodes, open-circuit potential; 1633
Potassium amalgam electrodes, studies; 1634, 2075
Potassium halides, solubility in organic solvents; 1228
Potassium hexafluoroarsenate, recrystallization; 1810
Potassium hexafluorophosphate solutes; 948, 1885
Potassium hydroxide additions, electrodes; 2187
Potassium hydroxide concentration, effects on overvoltages of silver; 794
Potassium hydroxide, electrical conductivity; 866

Potassium hydroxide, electrolytic conductivity; 1148
Potassium hydroxide solutions; 759, 3245, 3356, 3386, 3404
Potassium hydroxide solutions (30 percent); 761
Potassium hydroxide solutions (30-46 percent), electrical conductivity of pure and saturated zinc oxide; 745
Potassium hydroxide solutions (30-46 percent), vapor pressure (100-145 C); 745
Potassium hydroxide solutions, viscosity changes due to carbonate; 1850, 1988
Potassium hydroxide-zinc oxide electrolyte systems, studies; 745
Potassium ion reduction; 2051
Potassium perchlorate solutes; 1185
Potassium, properties in organic solvents; 1232
Potassium, reaction with organic solvents; 1107
Potassium tetrafluoroborate, heat of formation; 1164
Potassium thiocyanate solutes; 1185
Potassium thiocyanate solutes, ammonia; 1276
Potential cut-off, controlled, silver-zinc cells; 804
Potential decay theory; 626
Potential distribution experiments; 692
Potential, Flade; 594
Potential, high energy density electrode couples; 1130
Potential mapping; 692
Potential oscillations, during silver oxidation; 1471, 1521
Potential profile analysis, 1481
Potential, shifts; 724
Potential, steady-state; 594
Potential step methods; 1580
Potential sweep methods, 1411, 1602
Potential time curves, silver-zinc cells; 795
Potential variations over electrode surfaces; 780, 833
Potentiometric studies; 1064, 3145, 3376
Potentiostatic charging; 648
Potentiostatic charging techniques; 742, 878
Potentiostatic techniques, 247, 320, 594, 1102, 2062, 2129, 3369
Powder leveling apparatus; 1142
Power capacities, high energy batteries; 1214
Power load profiles, simulated space station; 1647
Power output, sealed cells (See Energy densities, sealed cells)
Power requirements, gas chromatography; 1804
Power requirements, space vehicles; 1661, 1662
Power requirements, Viking spacecraft; 1804
Power-sharing systems, satellites; 2117
Power sources, bibliographies; 268, 965
Power sources, comparison of energy densities; 871
Power sources, interchangeability; 1703
Power sources, selection; 1286, 1703, 2042
Power sources, space vehicles; 435, 657, 1420, 1661, 1662
Power sources, standardization; 1703
Power supplies, unfiltered; 1197
Precharge, nickel-cadmium batteries; 1799, 3393
Precharge studies, aerospace batteries; 2107, 3403, 3411, 3412

Precharged level, cadmium electrodes; 1379
Presealing treatments; 174
Pressure cells (experimental); 769A
Pressure changes; 576, 2041
Pressure changes during charging; 1301
Pressure changes during cycling; 624
Pressure control, auxiliary electrodes; 202, 355, 574, 598, 634, 655, 674, 682
756, 1108
Pressure control, constant current; 202
Pressure control, coulometer; 355
Pressure control, fuel cell; 889
Pressure control, nickel-cadmium cells; 86, 202, 355, 542, 606, 626, 720, 1108
2074, 2158
Pressure control, pressure switch; 598, 682
Pressure control, silver-cadmium cells; 674
Pressure control, silver-zinc cells; 593, 597, 663, 888
Pressure control, transducers; 603, 717, 867, 1108
Pressure control, venting; 644, 836, 1390
Pressure control, voltage limiters; 714
Pressure decay, nickel-cadmium cells; 607, 626, 653
Pressure decay, silver-zinc cells; 635, 735
Pressure effects, cell components; 2081
Pressure measurements, device, sealed cells; 1538
Pressure measurement techniques; 1101
Pressure, monitor, test technique; 1800
Pressure problems, monoblock; 1336
Pressure transients; 2130
Primary batteries, review; 1191, 2042, 2060, 3085
Primary batteries, space application; 1528
Primary cells, reviews; 3, 4, 7, 321
Primary cells, state-of-the-art; 1344
Primary reserve batteries; 567, 1599
Printout techniques; 615
Prismatic cell experiments; 1657
Problems, batteries; 614, 657, 796, 1553, 1554
Propellents, properties after sterilization (135 C); 1256
Propellents, silver-zinc cells, remotely activated; 1300
Propionitrile solvents; 1926
Propylene carbonate; 1599
Propylene carbonate-aluminum chloride electrolytes; 967, 1161, 1443
Propylene carbonate, analysis, 1097, 1556, 1603
Propylene carbonate, bibliography; 807
Propylene carbonate, bibliography on battery uses; 1135
Propylene carbonate-chloride electrolytes; 1131
Propylene carbonate, chromatographic analyses; 983, 1096, 1132, 1154, 1603
Propylene carbonate, compatibility with cell components; 1129
Propylene carbonate, decomposition on graphite; 1565
Propylene carbonate, dielectric permittivity measurements; 1584
Propylene carbonate, distillation; 1603

Propylene carbonate, effects of additives; 2113
Propylene carbonate, electroanalytical methods; 1025
Propylene carbonate, electrode reactions; 2038
Propylene carbonate, electrolysis, properties; 1107
Propylene carbonate, electrolyte; 2078
Propylene carbonate, electron paramagnetic resonance studies; 1025
Propylene carbonate, gassing rates during electrolysis; 1565
Propylene carbonate, heat of solution; 1489
Propylene carbonate-hexafluorophosphate electrolytes; 938, 941, 973, 976, 1042, 1208, 1209
Propylene carbonate-hexafluorophosphate electrolytes, properties; 1129
Propylene carbonate-Lewis acid electrolytes; 1131
Propylene carbonate-lithium-aluminum chloride electrolytes; 939, 957, 958, 961, 1023, 1043, 1089, 1159, 1503, 1597
Propylene carbonate-lithium-aluminum chloride electrolytes; 1503, 1950
Propylene carbonate-lithium-aluminum chloride electrolytes, equilibria; 1126
Propylene carbonate-lithium bromate-lithium perchlorate electrolytes; 1493
Propylene carbonate-lithium bromide electrolytes; 953, 954
Propylene carbonate-lithium perchlorate electrolytes; 932, 959, 960, 1238, 1247, 1269, 1954
Propylene carbonate-lithium perchlorate electrolytes, effects of water; 1020, 1021, 1224, 1288
Propylene carbonate-lithium perchlorate solvents, chromatography; 1019
Propylene carbonate-methylene chloride electrolyte; 1848
Propylene carbonate-morpholinium hexafluorophosphate electrolytes; 975
Propylene carbonate-nitromethane-aluminum chloride electrolytes; 1177
Propylene carbonate-nitromethane electrolyte; 1534, 1850
Propylene carbonate-nitromethane mixed solvents; 1187
Propylene carbonate-perchlorate electrolytes; 1086, 1114, 1222
Propylene carbonate-perchlorate electrolytes, effects of water; 1123, 1134, 1153
Propylene carbonate-perchlorate electrolytes, properties; 1288
Propylene carbonate-perchlorate hexafluorophosphate electrolytes; 1032
Propylene carbonate-phenyltrimethylammonium hexafluorophosphate electrolytes; 975
Propylene carbonate, purification; 1097, 1132, 1154, 1556
Propylene carbonate, review, electrochemistry; 1556, 2070
Propylene carbonate-silver chloride equilibria; 1128
Propylene carbonate solvents; 922, 923, 926, 930, 933, 936, 955, 962, 1186, 1188, 1190, 1244, 1278, 1295, 1606, 1795, 1902, 1905, 2043, 2188
Propylene carbonate solvents, bibliography; 956
Propylene carbonate solvents, conductivity measurements; 1268, 2108, 2109, 2112
Propylene carbonate solvents, ion conductances, 1600, 2070
Propylene carbonate solvents, physical properties; 1461
Propylene carbonate solvents, properties; 971, 1024, 1025, 1211, 1976
Propylene carbonate solvents, properties, temperature dependence; 1781
Propylene carbonate solvents, purification; 971, 1265, 1311, 2070
Propylene carbonate solvents, solubility; 1778, 2070
Propylene carbonate solvents, stability; 2070

Propylene carbonate solvents, voltage stability; 1604
Propylene carbonate, sound velocity; 1024
Propylene carbonate-tetrabutylammonium chloride electrolytes; 1628
Propylene carbonate-tetrafluoroborate electrolytes; 975
Propylene carbonate-tetramethylammonium hexafluorophosphate electrolytes; 975
Propylene carbonate-tetramethylammonium tetrafluoroborate electrolytes; 975
Propylene carbonate, viscosity; 1781, 2070
Propylene carbonate-water mixtures; 1907
Propylene glycol-sulfite mixed solvents; 1186
Propylene glycol-sulfite solvents; 1236, 1241, 1669
Pulse catalysis, polyoxygen anions; 1095
Pulse discharge nickel fluoride electrodes; 1211
Pulse charging, computer-controlled; 3198
Pulse power systems, 10 KW; 1865
Pulse power systems, performance forecast; 1356
Pulse power systems, primary-secondary hybrid batteries; 2017
Pulse techniques, mercury batteries; 1605
Pulse techniques, silver-zinc cells; 1930
Pulsed currents; types; 906
Pyrotechnic technique; 1923

Q

Qualification tests, nickel-cadmium cells; 1512, 1898, 1899, 1900
Quality assurance; 1499, 1500, 1838
Quality, batteries, definition; 1152, 2133
Quality control, magnesium-manganese dioxide dry cells; 1649
Quality control, nickel-cadmium cells, 1281, 3036, 3044, 3045, 3046, 3381
Quinone electrodes, positive; 1943
Quinones, in acetonitrile; 1943
Quinone, in propylene carbonate; 1943

R

Radiation effects, batteries; 189, 190, 239, 362, 788, 795
Radiation effects, nickel-cadmium batteries; 1611, 1612
Radiation effects, silver-zinc cells; 970
Radio batteries; 329
Radioactive batteries, patents; 1814
Radioactive iron; 907
Radioactive silver; 235, 351, 460, 555, 687
Radioactive techniques, battery application; 1756
Radioactive zinc; 271, 324
Radiography; 3178
Radioisotope space power systems; 1661
Radiolysis, potassium hydroxide; 239
Radiotracer techniques; 451, 660
Raman spectroscopy, laser; 3139, 3145
Ranger spacecraft batteries; 432
Rare earth ion additions, electrolytes; 817, 1993
Reaction mechanism apparatus; 606
Recharge unit (percent), design; 917

Recharging characteristics; 102, 121, 458, 482, 1836
Recharging characteristics, nickel sulfide electrodes; 1366
Recharging characteristics, rapid, nickel-cadmium sealed cells; 1197, 2074
Recharging characteristics, silver electrodes; 2156
Recharging concepts, electrochemical batteries; 1832
Recharging with cycle life; 820
Recharging methods, metal-air cells; 1830
Recharging methods, silver-zinc cells; 1930, 2125
Recharging rates; 1515
Recombination electrodes, characterization; 1799
Recombination electrodes, nickel-cadmium cells; 440, 510, 844, 1333, 1629
1951, 2041'
Recombination electrodes, nickel-zinc cells; 2066
Reconditioner systems; 634
Reconditioning devices, automatic; 383
Recording systems, automatic; 322, 498
Rectifier-firing circuits, silicon-controlled; 827
Rectifier shunts; 856
Rectifiers, high voltage, high speed; 790A
Redox air electrodes; 1176
Redox couples, utilization in coulometer; 1596
Redox electrodes; 879
Redox electrodes, acids; 887
Reference electrodes, amide solvents; 1314
Reference electrodes, copper in hydrogen fluoride; 1097
Reference electrodes, lithium; 1037
Reference electrodes, mercury-mercuric oxide assembly; 1376
Reference electrodes, mercury-mercuric oxide assembly; 1376
Reference electrodes, microcracked Pyrex; 1277
Reference electrodes, organic electrolyte systems; 1229
Reference electrodes, organic electrolytes; 1190, 1243, 1778
Reference electrodes, organic electrolytes, silver; 1268
Reference electrodes, organic solvents; 1501, 1543, 1561
Reference electrodes, organic solvents, review; 1397
Reflectance measurements, electrode surfaces; 1667, 2005, 3079
Reflection coefficients, electrode surfaces; 1487
Reflection coefficients, electrolytes; 1162
Refractive index, organic solvents; 1075
Regenerative electrochemical systems; 796, 2061
Regression analysis, cell data; 1544, 3029
Relaxation methods; 1605
Reliability, communications equipment; 892
Reliability, electron relay devices; 799
Reliability, nickel-cadmium cells; 486, 1744, 1971, 3089, 3377
Reliability, silver-zinc cells; 1835
Reliability, spacecraft batteries; 387, 419, 466, 482, 561, 1213, 1531, 1863, 3075
Remotely activated silver-zinc batteries; 1636
Research, batteries, forecast; 2089
Research, batteries, Government-supported, summary; 796
Research, batteries, NASA-supported, summary; 1448
Research, batteries, problem areas; 796

Research, batteries, recommended areas; 796
Reserve batteries, engineering evaluation; 1641
Reserve batteries, review; 1191
Reserve delayed action cells; 4
Reserve type power supplies; 593
Resistance to heat sterilization (145 C); 662
Resistance to high impact (10,000 gravity); 662
Resistance, ionic; 1488
Resistivity, effects of compression; 690
Resistivity, electrical, ion exchange membranes; 1182
Resistivity measurements, organic electrolytes; 1094, 1098, 2043
Resonant frequency techniques, state-of-charge indicators; 98
Reversal, cells, prevention; 1062
Reversal, nickel-cadmium cells; 203, 337, 414, 706, 774, 830, 3393
Reverse polarity charge protection; 774
Rolling mill, silver electrodes; 1673, 1819
Rotating disk electrodes, organic electrolytes; 807, 1159, 1247
Rotating electrodes, gold, oxygen evolution; 607
Rotating electrodes, zinc, growth studies; 522
Rotating membrane unit, silver-zinc cells; 1464
Rotation tests, nickel-cadmium batteries; 588
Rubidium additions, electrolytes, 336, 360, 370, 430
Rubidium halides, solubility in organic solvents; 1228
Rubidium hydroxide electrolytes, density; 1616
Rubidium, properties in organic solvents; 1232
Rubidium tetra-silver, pentaiodide solid electrolytes; 1282

S

Safety factor concepts; 1213
Sandwich electrodes; 149
Satellite batteries; 912, 1512, 1520, 2117
Satellite batteries, spacecraft history; 1531
Satellite batteries, temperature changes; 1065
Satellite battery monitor; 1991
Satellite power, operation conditions; 2117
Satellite power, performance constraints; 2117
Satellite power sources; 800, 1809
Satellite power systems, electrical analog characteristics; 461
Satellite subsystems, 433
Scale-up effects, lithium-copper fluoride cells; 1247
Scandium additions, nickel electrodes; 1395
Scanning electron microscopy; 3195
Scanning electron microscopy, lead-acid batteries; 1870
Scanning electron microscopy, nickel-cadmium electrodes; 1630, 3016, 3371
Scanning electron microscopy, silver electrodes; 1734
Scavengers, oxygen getter electrodes; 508, 619
Schematic diagrams, watt-hour meter; 1798
Sea water electrolytes; 1357, 2121

Sealants, mercury-cadmium cells; 1812
Sealing techniques; 156, 385, 662, 663, 737, 822, 848, 858, 866
Sealing techniques, crimped; 111, 599
Sealing techniques, nickel-cadmium cells; 1701, 1702, 2046, 3032, 3096
Sealing techniques, silver-zinc cells; 823, 1221, 1252, 1336
Seals; 680
Seals, bonded elastomeric; 839
Seals, ceramic; 467, 468, 478, 539, 556, 607, 626, 710, 1150, 1800, 3175
Seals, ceramic-to-metal; 822, 1253, 1553
Seals, ceramic-to-metal, nickel-cadmium cells; 1553, 1631, 2003, 3057, 3058
Seals, ceramic-to-metal specifications; 1978
Seals, ceramic with nickel braze; 1841
Seals, ceramic, thermal stress reduction; 332
Seals, chemical; 911
Seals, compression; 1253, 1702, 3026, 3071, 3074
Seals, cover-to-case; 597, 735, 1221, 1390, 2001
Seals, crimped polymeric; 1401, 1454, 1613
Seals, elastomer-to-metal; 822
Seals, evaluation; 822, 3026
Seals, failure definition; 1253
Seals, failure modes, 1253, 1648, 1702
Seals, glass-to-metal; 643, 822, 832, 919, 1253, 1630, 1631
Seals, hermetic, commercially available; 1253
Seals, hermetic, ideal; 822, 3071, 3074
Seals, hermetic, secondary spacecraft cells; 787
Seals, hermetic, state-of-the-art; 822, 1253
Seals, high pressure, Ziegler; 1324, 1702
Seals, manufacturing methods; 787
Seals, metallic; 1613
Seals, neoprene; 283, 507, 526, 639, 802, 1149
Seals, neoprene-to-metal; 635
Seals, nickel-cadmium batteries; 8, 37, 1613, 3390
Seals, nickel-cadmium cells; 1253, 1281, 1432
Seals, plastic-to-metal; 822, 1253, 1290, 1631, 1968
Seals, requirements; 645
Seals, ring; 559
Seals, rubber; 542
Seals, rubber-to-metal; 729
Seals, silver-cadmium cells; 1253
Seals, silver-zinc cells; 233, 597, 635, 1253
Seals, terminal; 735, 1996, 2001, 2110
Seals, terminal, molded; 233, 624
Seals, testing procedures; 787, 2128
Seals, tubular; 1613
Seals, types; 787
Seals, Ziegler, modified; 1800, 2128
Secondary batteries; 641
Secondary batteries, life tests; 1
Secondary batteries, review; 1191, 1815, 2042
Secondary batteries, space application; 1528

secondary cells, reviews; 1, 3, 4, 7, 12, 25, 321, 362, 364, 366, 374, 386,
387, 395, 396, 417
secondary cells, state-of-the-art; 1344
selection, battery types; 1, 3, 4, 7, 10, 64, 65, 90, 118, 545, 875, 885,
1875, 1876, 1942, 1944
selenium amalgam electrodes, studies; 2075
self discharge (See Discharge, self)
separation processes; 713
separator characterization studies; 789, 1052, 1066, 1218, 1303, 1658, 2106, 3171, 3235
separator degradation; 459, 551, 673, 712, 733, 738, 763, 970, 1354, 1629,
1884, 2020, 2066
separator degradation products; 673
separator degradation from sterilization; 733
separator design; 146, 566, 1708
separator design, double layer; 2064
separator deterioration, silver-zinc cells; 712, 970, 3235, 3384
separator development; 661, 690, 709, 764, 792, 868
separator development, heat sterilizable batteries, 791, 869, 1055, 1488,
1526, 1638, 1715, 1719
separator development, silver-cadmium cells; 439, 496, 711, 712, 769, 966, 1717
separator development, silver-zinc cells, 367, 439, 711, 712, 769, 831, 1170,
1171, 1203, 1354, 1388, 1398, 1400, 1713, 1714, 1716, 1718, 1720, 1751, 3294
separator drying, review; 1385
separator envelopes; 769
separator evaluation; 496, 645, 651, 3078, 3235
separator evaluation, organic electrolytes, 1085
separator fabrication; 146, 522, 868, 895, 1715, 2163, 2167, 3294
separator films formed on electrodes; 116, 138, 496, 1831
separator materials, absorber-type; 1658
separator materials, alkaline electrolyte cells; 1449, 3294
separator materials, alumina; 2045
separator materials, ceramic; 1877, 2045, 2168
separator materials, classification; 1705
separator materials, comparative studies; 1297, 3235
separator materials, composition; 711
separator materials, fibrous, physical characteristics; 763, 1666, 1708, 2064
separator materials, gel; 2167
separator materials, magnesium oxide; 2126
separator materials, nickel-cadmium cells, 38, 191, 215, 242, 303, 385, 478,
556, 585, 587, 607, 626, 716, 893, 1378, 1686, 2003, 2106, 3078, 3171, 3294, 3384,
3390, 3408
separator materials, nickel-zinc cells; 1364, 2167
separator materials, non-aqueous batteries; 1797
separator materials, nonwoven; 1800
separator materials, nylon, 2046, 3066
separator materials, polymer film; 1638, 2161, 2163
separator materials, polypropylene; 959, 961, 1630, 1710, 1816, 1975, 2078
separator materials, review; 2157
separator materials, selection; 1810, 1812, 2063

separator materials, silver-cadmium cells; 191, 275, 439, 458, 468, 496, 645, 660, 687, 769, 866, 1609, 1732
separator materials, silver-zinc cells; 208, 209, 229, 231, 238, 365, 367, 389, 409, 436, 437, 439, 450, 451, 459, 484, 537, 555, 563, 581, 583, 635, 660, 662, 663, 672, 687, 731D, 769, 781, 866, 969, 970, 1290, 1361, 1414, 1426D, 1426E, 1712, 1731, 1815, 1838, 1878, 2001, 2045, 2134, 2167, 2168, 3235, 3294
separator materials, specifications; 1978
separator materials, spectroscopic analyses; 832
separator materials, storage effects; 1806
separator materials, zinc-air cells; 1827, 2045
separator materials, zinc-mercuric oxide batteries; 1901
separator mechanisms, review; 547
separator membranes, Beta-alumina; 2012
separator problems, 16, 911, 1281
separator properties, evaluation; 1171, 1431, 1586, 1658
separator requirements, future; 1704
separator resistance; 1940
separator screening methods; 661, 738, 769A, 789, 804, 832, 866, 1066, 1218 1303, 1354, 1431, 1648, 1658, 1846
separator screening tests; 1940
separator strips; 2105
separator studies, lead-acid battery; 1704
separator studies, nickel-cadmium cells; 8, 36, 37, 54, 77, 191, 378, 1704, 2024, 3384
separator studies, silver-cadmium cells; 8, 191, 275, 304, 439, 458, 496, 600
separator studies, silver-zinc cells; 367, 439, 459, 660, 671, 731, 1467, 1704
separator studies, zinc-oxygen cells; 1057
separator testing; 238, 1398, 2024, 2106
separators, review; 556, 607, 1250
separators, adsorption of potassium hydroxide; 832, 1221
separators, aging in potassium hydroxide; 1170, 1398
separators, alkaline earth hydroxides, properties; 1353
separators, ammonia batteries, 1105, 1657
separators, asbestos; 242, 365, 1636
separators, binders, organic; 791
separators, ceramic organic electrolytes; 1877
separators, charge retention, silver-zinc cells; 1718
separators, classification; 769, 1316
separators, coating techniques; 791, 869, 1055, 1398
separators, combinations of two films, 712
separators, compressed; 704, 854
separators, copolymers; 792, 841, 868, 966, 1713
separators, cotton; 1636
separators, dimensional changes; 789, 1719, 1731
separators, effect of storage time, and temperature, silver-zinc cells; 1718
separators, electrical resistance; 789, 1052, 1354, 1361, 1426E, 1706, 1719, 1878
separators, electrolyte absorption; 537, 738, 789, 792, 1052, 1354, 1709, 1710, 1731

Separators, electrolyte retention; 738, 789
Separators, energy dissipation rates, 1705
Separators, exchange capacity; 1426E
Separators, fiberglass, in organic electrolytes; 959
Separators, filler, zirconia; 791, 869, 1715
Separators, flexible; 2046
Separators, gas permeability; 1709
Separators, grafted; 2024, 3294
Separators, grafting procedures; 1361, 1400, 1414, 1426E, 1639, 1640, 1878, 1940, 2022
Separators, impregnation; 1963
Separators, inorganic, organic electrolytes; 1877
Separators, ion exchange membranes, properties; 1188
Separators, irradiation; 764, 769, 841
Separators, organic batteries; 1245, 1280, 1850
Separators, organic electrolytes; 922, 925, 938, 941, 942, 951, 952, 987, 988, 990, 1042, 1086, 1186, 1307, 1311, 1329, 1534, 1759, 1903
Separators, oxidation resistance; 789, 1709, 1731
Separators, palladium content; 1429
Separators, permeability; 879, 1510, 1666, 1731
Separators, physical properties, 789, 1218
Separators, plastic; 1706
Separators, polar additives; 712
Separators, polyethylene; 231, 365, 459, 1638, 1640, 1709, 1940, 2022, 2024, 2067
Separators, polyethylene, in organics; 1493
Separators, polypropylene, 1630, 1710, 1816, 1975
Separators, polypropylene, in organic electrolytes; 959, 961
Separators, pore size, 537, 789, 1052, 1316, 1354, 1731, 2126
Separators, pore size determination; 661, 738, 763
Separators, pore size distribution; 1706
Separators, porosity; 1052, 1472, 1706, 2078, 2150
Separators, porosity, microscopic estimates, review; 1666
Separators, precooling, review; 712, 769
Separators, presoaking, review; 712
Separators, preswelling treatments, review; 769
Separators, properties after sterilization (135 C and 140 C); 792, 868, 1256, 1417, 1710, 1713, 1715
Separators, quality control tests; 1709, 1719, 1940
Separators, resistivity; 769A, 792, 868, 869, 1055, 1414, 2150
Separators, resistivity measurements, 522, 1095, 1296, 1297, 1666
Separators, resistivity in organics; 959, 1187, 1188, 1327, 1810
Separators to restrict copper migration; 1244
Separators, rubber, microporous, in organic electrolytes; 960
Separators, sapenification; 966
Separators, shear strength; 1221
Separators, silver adsorption; 789, 1878
Separators, silver content; 624, 646, 789, 1052, 1068, 1429, 1587, 1658
Separators, stability; 1354

Separators, stability in organics; 537, 945, 1092, 1093, 1095, 1184, 1426E
1710, 1720
Separators, stability in potassium hydroxide; 537, 1426E, 1710, 1720, 1878
Separators, sterilizable, developments; 788
Separators, sterilization resistance; 869, 1055, 1719
Separators, sterilization techniques; 1066
Separators, sterilization tests (135 C); 1055, 1398
Separators, sterilized absorption characteristics; 1300
Separators, swelling characteristics; 1426E
Separators, tensile strength; 537, 789, 792, 868, 966, 1052, 1354, 1426E,
1719, 1731
Separators, tensile strength measurements; 738, 763
Separators, terpolymers; 792, 966
Separators, test procedures; 1731
Separators, tetrapolymers; 868
Separators, thermal and chemical stability; 832
Separators, thin, review; 854
Separators, tortuosity; 789, 1731
Separators, transport characteristics; 731C
Separators, ultrafine membranes; 1712
Separators, use of wetting agents; 1055
Separators, wettability studies; 1378, 1706, 1710
Separators, zeolites; 1353
Separators, zinc adsorption; 1052, 1658, 1731, 3228
Shaping techniques; 627
Shelf life evaluation; 659
Shelf life, high energy batteries; 871
Shelf life, high energy density batteries; 1177, 1947
Shelf life, nickel sulfide electrodes; 1392
Shelf life, primary cells, 1178
Shelf life, reserve batteries; 1641
Shock analysis; 866
Shock equipment; 588
Shock tests; 597, 616, 1053
Shock tests, operative; 421, 595, 737
Shock tests, silver-zinc cells; 1459, 1835
Short circuit data; 561, 3201
Shunt voltage regulators; 634, 1938
Silicon additions, alkaline electrolyte; 1965
Silicon additions, silver-oxide samples; 1593
Silicon diodes; 699
Silicon oxide additions, electrolytes; 838
Silver, active, weight measurements per plate; 1290
Silver additions, cadmium electrodes; 719
Silver additions, copper fluoride electrodes; 1793
Silver additions, lead electrodes; 1959
Silver additions, mercury electrodes; 1557
Silver additions, nickel hydroxide electrodes; 3263, 3268
Silver additions, potassium hydroxide solutions; 161, 327

Silver additions, zinc electrodes; 502, 505, 518, 1250, 1653
Silver-aluminum cells, patents; 1814
Silver (Argentate I) complex, composition in alkaline solutions, 778
Silver bromide, removal by photochemical decomposition; 1881
Silver-cadmium batteries, life tests, 458
Silver-cadmium batteries, maintenance-free; 1429
Silver-cadmium batteries, patents; 1814
Silver-cadmium batteries, performance; 118, 249, 264, 272, 419, 421, 457, 458, 618, 756, 875, 885, 1068
Silver-cadmium batteries, sealed; 1069, 1367, 1520
Silver-cadmium batteries, sealed 5 ampere hour; 1418
Silver-cadmium batteries, sealed, 12 ampere hour; 1438
Silver-cadmium batteries, sealed, 20 ampere hour; 963
Silver-cadmium batteries, unsealed, dry, activation; 1520
Silver-cadmium cells; 789, 806, 842, 866, 877, 891, 1052, 1066, 1109, 1218, 1303
Silver-cadmium cells, design; 4, 7, 29, 69, 72, 101, 191, 249, 259, 267, 512, 618, 1610, 1645
Silver-cadmium cells, electrical characteristics; 1645, 2153
Silver-cadmium cells, electrode processing specifications; 1837
Silver-cadmium cells, fabrication; 1068
Silver-cadmium cells, performance, effects of charge rate; 2094
Silver-cadmium cells, performance, effects of depth of discharge; 2094
Silver-cadmium cells, performance, effects of storage time; 1582
Silver-cadmium cells, performance, effects of temperature; 304, 364, 421, 1582, 1884, 2094
Silver-cadmium cells, physical characteristics; 1645
Silver-cadmium cells, reactions; 707
Silver-cadmium cells, review; 1294, 3025
Silver-cadmium cells, sealed; 888, 911, 1137, 1441
Silver-cadmium cells, sealed, compared with nickel-cadmium cells; 1347
Silver-cadmium cells, sealed, rechargeable; 1609
Silver-cadmium cells, space application; 1528, 1884
Silver chloride-cadmium tape cells; 1282
Silver chloride electrodes; 942
Silver chloride electrodes, cycling behavior; 930, 1003
Silver chloride electrodes, formamide; 1372
Silver chloride electrodes, mass transport; 951
Silver chloride electrodes, organic electrolytes; 980, 981, 1519
Silver chloride in organic solvents; 1543
Silver chloride electrodes, potential versus hydrogen; 1040
Silver chloride electrodes, preparation; 937, 1012, 1272, 2109
Silver chloride electrodes, utilization; 929, 937, 940, 953
Silver chloride equilibria, propylene carbonate; 1128
Silver chloride, heat of precipitation in formamide; 1372
Silver chloride-magnesium cells, 1357, 2121
Silver chloride plates; 871
Silver chloride primary cells; 4, 10, 64, 69, 80, 2121
Silver chloride reference electrodes, dimethylacetamide; 1040

Silver chloride, solubility in formamide; 1372
Silver chloride, solubility in organic electrolytes; 1157, 1160, 1180
Silver chloride, solubility in propylene carbonate; 937, 938, 940, 952, 1039, 1046, 1128, 1157
Silver chloride, solubility in propylene carbonate-water mixtures, 1039
Silver chloride, standard potential in formamide; 1372
Silver chloride, utilization in silver electrodes, 2113
Silver chloride-zinc cells, 1282, 2121
Silver compacts, fabrication; 899
Silver compounds, thermodynamic data; 1338
Silver-copper alloy electrodes; 807
Silver-copper cells, patents; 1814
Silver density; 583
Silver deposition, zinc; 1204
Silver deposition, zinc electrodes; 891, 1330, 1331, 1423
Silver diffusion through membranes, 738, 769, 1398
Silver diffusion through membranes, rate; 1203
Silver dioxide, thermal decomposition; 422
Silver, electrochemical behavior; 199, 344, 492, 519
Silver electrodes, adsorption of oxygen; 485
Silver electrodes, anodic behavior in alkaline solutions; 291, 354, 1684
Silver electrodes, anodic overvoltages; 794
Silver electrodes, anodized; 1734
Silver electrodes, argentic; 517, 525, 562
Silver electrodes, automated rolling process; 1791
Silver electrodes, buoyancy; 519
Silver electrodes, capacitance during film formation; 1102
Silver electrodes, carbonized; 1614
Silver electrodes, cathodic behavior in alkaline solutions; 348
Silver electrodes, cathodic overvoltages; 794
Silver electrodes, characterization; 1688
Silver electrodes, charge acceptance, 1255, 1380, 1421, 1471, 1521, 1585, 1734
Silver electrodes, charge characteristics; 1419
Silver electrodes, charging characteristics; 1347, 1677
Silver electrodes, charging platforms; 725
Silver electrodes, cleaning; 874
Silver electrodes, coated; 1218
Silver electrodes, coated with calcium hydroxide; 496, 872
Silver electrodes, commercial, organic residues; 788
Silver electrodes, coulgravimetric studies; 519
Silver electrodes, coulometric efficiency; 485
Silver electrodes, cycling behavior; 325, 514, 576, 580
Silver electrodes, discharge capacity; 348, 400
Silver electrodes, discharge characteristics; 1419, 2062
Silver electrodes, doped; 275
Silver electrodes, effective surface; 278, 459
Silver electrodes, effects of nickel additives; 2113
Silver electrodes, effects of oxidation rates; 1688

Silver electrodes, effects of sterilization; 1109, 1417
Silver electrodes, effects of thickness on cell capacity; 1252, 2062
Silver electrodes, effects of ultrasonic waves; 278
Silver electrodes, electrical capacitance; 228
Silver electrodes, electrochemical behavior; 783, 1783, 1815, 2062, 2173
Silver electrodes, electrolyte content; 312
Silver electrodes, fabrication; 8, 191, 208, 266, 296, 363, 428, 480, 493
564, 568, 570, 571, 951, 952, 1340, 1377, 1783, 2113
Silver electrodes, film formation kinetics; 1911
Silver electrodes, gridless; 1783
Silver electrodes, irradiation effects; 795
Silver electrodes, layered structure; 1783
Silver electrodes, loading levels; 395
Silver electrodes, low temperature operation; 514, 1576
Silver electrodes, microscopic study; 1636
Silver electrodes, microstructure changes; 1536, 1668, 1687, 1688
Silver electrodes, model pore; 1471, 1521
Silver electrodes, morphology; 1734
Silver electrodes; organic electrolytes; 492, 978, 979, 981, 1001
Silver electrodes, organic residues; 692, 833
Silver electrodes, overloading effects; 1347
Silver electrodes, oxidation; 347, 349, 384, 692, 780, 824, 833, 874, 1102,
1201, 1255, 1288, 1298, 1380, 1471, 1521, 1585, 1678, 1687, 1730,
1881, 2076
Silver electrodes, partial decomposition; 724
Silver electrodes, particle size variance; 515
Silver electrodes, pasted; 1441, 1609
Silver electrodes, performance data; 1673, 1819
Silver electrodes, performance, effects of crystal morphology; 1536
Silver electrodes, planar, charge acceptance; 1222
Silver electrodes, pore size; 1288, 2076
Silver electrodes, porous; 495, 2062
Silver electrodes, porous, charge acceptance; 1222
Silver electrodes, potential in potassium hydroxide; 410
Silver electrodes, powdered; 725
Silver electrodes, preparation; 1815
Silver electrodes, pretreatment; 1974
Silver electrodes, reaction studies; 715, 2076
Silver electrodes, reduction; 692, 780, 824, 833, 874, 1102, 1201, 1380, 1585
Silver electrodes, roughness factors; 833, 874, 1102, 1255, 1298, 2076
Silver electrodes, stability; 1450
Silver electrodes, sterilized, growth studies; 1300
Silver electrodes, surface area; 1222, 1510
Silver electrodes, surface area estimation; 752, 833, 1380, 2076
Silver electrodes, surface area measurements; 780, 874, 1102, 1255, 1288, 1298,
2005
Silver electrodes, surface preparation; 692, 824
Silver electrodes, temperature coefficients; 1786

Silver electrodes, tortuosity factors; 1288
Silver electrodes, utilization coefficient; 2156, 2174
Silver electrodes, vapor deposited; 1201
Silver electrodes, voltammetry; 807
Silver electrodes, weighing; 519
Silver electrodes, wire bundles; 1521
Silver electrodes, X-ray diffraction studies; 521
Silver electrodes, zirconium grids; 1137
Silver fluoride electrodes; 1031
Silver fluoride electrodes, butyrolactone solvents; 1519
Silver fluoride electrodes, organic electrolytes; 979
Silver fluoride electrodes, organic solvents; 1586
Silver fluoride electrodes, preparation; 928, 1208
Silver fluoride, free energy of formation; 1031
Silver fluoride, solubility in organic electrolytes; 1180
Silver-gold alloys, performance in concentrated caustic electrolytes; 807
Silver halide, formation on silver electrode surface; 1881
Silver-iodine cells, patents, 1814
Silver-iodine tape cells; 1282
Silver ion diffusion, effects of zincate; 711
Silver ion diffusion rates, 1055, 1713
Silver ion diffusion through separators; 439, 451, 484, 660, 687, 690, 711, 869, 1719
Silver ion migration; 1488, 1640
Silver ions, response to glass electrodes; 810
Silver-iron cells, patents; 1814
Silver-lead alloy electrodes; 807
Silver losses on cell walls; 451
Silver migration; 101, 231, 232, 233, 236, 411, 412, 413, 460, 503, 515, 555, 580, 645
Silver migration during cycling; 624, 1109
Silver migration, reduction; 636, 872
Silver migration, silver-cadmium cells; 1732
Silver oxidation, alkaline electrolytes; 1325, 1411, 1974, 3327
Silver oxidation, organic electrolytes; 935
Silver oxidation, stress effects; 1380
Silver oxide, activation temperature requirements; 1633
Silver oxide, activation time requirements; 1633
Silver oxide, anodic film formation; 554, 1674
Silver oxide cells, engineering data; 1179, 1944
Silver oxide cells, performance, present and predicted; 1350
Silver oxide, charging with asymmetric current; 808
Silver oxide, chemically prepared; 898
Silver oxide coatings, analysis; 752
Silver oxide coatings, thickness; 752
Silver oxide, crystal growth; 1674
Silver oxide, decomposition; 457, 503, 504, 505, 518, 590, 687, 1404
Silver oxide, decomposition rate; 1653, 1654
Silver oxide, dissociation rates; 457, 1169

Silver oxide, doped electric resistivity; 1593
Silver oxide dry primary cells; 69
Silver oxide, electrochemical behavior; 1974
Silver oxide, electrochemical preparation; 788
Silver oxide electrodes, activation; 590
Silver oxide electrodes, anode reactions; 1464
Silver oxide electrodes, capacity; 1144, 1145, 1146, 2172
Silver oxide electrodes, charging; 1144, 1145, 1146
Silver oxide electrodes, charging with asymmetric a.c.; 753
Silver oxide electrodes, electrical testing; 1789, 1790, 1791
Silver oxide electrodes, microscopic study; 1417
Silver oxide electrodes, organic electrolytes; 492, 928, 953, 954, 955, 978, 994, 1079, 1080, 1091, 1103, 1233, 1245, 1321
Silver oxide electrodes, organic electrolytes, polarization, 992, 993
Silver oxide electrodes, oxidation potential, 345
Silver oxide electrodes, performance at low temperature; 514
Silver oxide electrodes, preparation, 425, 428, 568, 572, 808, 1070, 1575
Silver oxide electrodes, preparation, continuous rolling; 1672, 1673, 1819
Silver oxide electrodes, preparation, dry pressing; 1672, 2123
Silver oxide electrodes, preparation, pressed; 1789
Silver oxide electrodes, processes; 794
Silver oxide electrodes, quantitative analysis; 517
Silver oxide electrodes, review; 516
Silver oxide electrodes, thin, physical characteristics; 1872
Silver oxide film formation; 554
Silver oxide film resistance; 1298, 1380
Silver oxide, formation in alkaline solution; 1881, 1974
Silver oxide, growth in electrode pore; 1471, 1521
Silver oxide, instability; 551
Silver oxide, oxidation; 808
Silver oxide, particle size; 1687
Silver oxide, paste, preparation; 2123
Silver oxide, permeation rates in separators; 789, 1052
Silver oxide, preparation; 517
Silver oxide, preparation, electrochemical; 707
Silver oxide, reaction with separators; 581, 583
Silver oxide, reduction, alkaline electrolytes; 590, 1411
Silver oxide, reduction to free silver; 646
Silver oxide, single crystal preparation; 1734
Silver oxide, solubility; 1340, 1377
Silver oxide, solubility in chelating solutions; 1068
Silver oxide, solubility in electrolytes for silver-zinc cells; 1365
Silver oxide, solubility in potassium hydroxide; 518, 551, 554, 662, 687, 785, 843, 866, 1068, 1147, 1205, 1331, 1365
Silver oxide solutions; 580
Silver oxide, thermal decomposition; 843, 1204, 1205, 1423, 1466, 2075
Silver oxide, thermogravimetric investigations; 560, 788, 891, 1464
Silver oxide, utilization factor; 808
Silver (I) oxide, reduction in alkaline solutions; 1325, 1466

Silver (II) oxide, formation in alkaline solutions; 1326
Silver (II) oxide, reduction in alkaline solutions; 1326
Silver(-ic) oxide, thermal decomposition; 785
Silver(-ous) oxide, solubility equilibria in alkaline media; 779
Silver(-ous) oxide, solubility in sodium perchlorate; 778
Silver-oxygen ratios; 752
Silver oxynitrate electrodes, organic electrolytes; 994
Silver-palladium; 580
Silver-palladium alloys, double layer capacitance; 807
Silver-palladium alloys, performance in concentrated caustic electrolytes; 807
Silver peroxyxynitrate, chemical stability; 1464
Silver peroxyxynitrate, conversion to silver oxide; 1510
Silver peroxyxynitrate, electrical resistivity; 1464
Silver peroxyxynitrate, leaching; 1464
Silver plaques, impregnation with cadmium salts; 1837
Silver plaques, preparation; 2065
Silver plates, chemical characteristics; 1290, 1648
Silver plates, electroformation; 651
Silver plates, oxidation; 715
Silver plates, physical characteristics; 1290, 1601, 1648
Silver plates, preparation; 715
Silver plates, specifications; 1388
Silver powder additions, silver oxides; 1790
Silver powder electrodes, positive; 564
Silver powder, surface area measurements; 272
Silver radioactive; 236, 351, 460, 555, 581, 711
Silver (I) reduction; 2075
Silver reference electrodes; 962, 1107
Silver-rubidium-iodide cells; 1855
Silver-silver bromide reference electrodes; 1081
Silver-silver chloride electrodes, dimethylacetamide; 1040
Silver-silver chloride electrodes, n-methylformamide; 1561
Silver-silver chloride electrodes, organic electrolytes; 1001
Silver-silver chloride half-cells; 550
Silver-silver chloride reference electrodes; 1001
Silver-silver chloride reference electrodes; 1040
Silver-silver iodide-platinum cells, discharge curves; 1855
Silver-silver ion electrodes, organic electrolytes; 1001
Silver/silver oxide electrodes, anodic charge, polarization; 1674
Silver/silver oxide electrodes, cathodic charge, polarization; 1674
Silver/silver oxide electrodes, design; 1916
Silver/silver oxide electrodes, electrical characteristics; 1913
Silver/silver oxide electrodes, performance, cathodic; 1674, 1913, 1916
Silver-silver perchlorate half-cells; 550
Silver (II) to silver (I) conversions; 617
Silver slurries; 572
Silver solubilities, measurements; 708, 777
Silver solubility, chelating solutions; 646

Silver solubility, potassium hydroxide; 343, 350, 410, 518, 891
Silver species, solubility in potassium hydroxide; 1202, 1426D
Silver stability studies; 315
Silver sulfide; 1540
Silver sulfide electrodes, fabrication; 1787
Silver surface processes, potentiodynamic examination; 1325, 1326
Silver systems, organic electrolytes; 1305
Silver thiccyanate electrodes; 1659, 1754
Silver thiocyanate electrodes, passivation in organic electrolytes; 1088
Silver-tin cells; 1689
Silver (110) tracers; 110, 581
Silver transport; 687
Silver-vanadium oxide cells, patents; 1814
Silver-zinc batteries, applications; 885, 1815
Silver-zinc batteries; design; 607, 764, 884, 1290, 1388, 1815, 2016, 2127, 2134
Silver-zinc batteries, electrode structural design; 807, 837, 1202B, 1468, 1834
Silver-zinc batteries, patents; 1814
Silver-zinc batteries, performance and cost data ; 875
Silver-zinc batteries, performance prediction; 758
Silver-zinc batteries, primary, design characteristics; 1468
Silver-zinc batteries, primary, rechargeable; 621, 2127
Silver-zinc batteries, primary, rechargeable, 70 ampere hour; 1422, 1587
Silver-zinc batteries, problems; 614
Silver-zinc batteries, remotely activated; 1765
Silver-zinc batteries, review; 1815, 3025
Silver-zinc batteries, sealed; 1069, 1367
Silver-zinc batteries, sealed, capacity ratings; 963, 1289, 1290, 1293, 1422, 1437, 1648, 1835
Silver-zinc batteries, sealed, forecast of capabilities; 1348
Silver-zinc batteries, sealed, high impact; 1422, 1587, 1834, 1835, 1975
Silver-zinc batteries, sealed, historical development; 1348, 1350
Silver-zinc batteries, sealed, problems; 1348
Silver-zinc batteries, sealed, state-of-the-art; 1348, 1350, 1834
Silver-zinc batteries, sealed, structural design; 679, 680
Silver-zinc batteries, sealed, zero-gravity environment; 1141, 1381
Silver-zinc batteries, status; 1286, 2042
Silver-zinc batteries, tile construction; 329
Silver-zinc batteries, vented, problems; 1348
Silver-zinc battery, BA-494 ()/U; 588
Silver-zinc cells, 5 ampere hour; 1221
Silver-zinc cells, automatically activated; 1800
Silver-zinc cells, cycle life, 50 percent depth of discharge; 1975, 2016
Silver-zinc cells, cycle life, 60 percent depth of discharge; 1202
Silver-zinc cells, design; 4, 7, 29, 69, 259, 260, 267, 329, 376, 621, 735, 842, 1645, 1834, 1835, 1836, 1975, 2001, 2008, 2067
Silver-zinc cells, different designs; 1399
Silver-zinc cells, electrical characteristics; 1645
Silver-zinc cells, fabrication; 635, 662, 866
Silver-zinc cells, fabrication sequence; 1388

Silver-zinc cells, laser applications; 1750
Silver-zinc cells, life tests; 250, 439, 968
Silver-zinc cells, performance; 118, 208, 212, 251, 264, 376, 387, 767, 768, 806, 866, 872, 891, 1171, 1836, 1930
Silver-zinc cells, performance, before and after sterilization; 1459
Silver-zinc cells, performance, effects of storage time; 1582, 1765, 1806
Silver-zinc cells, performance, effects of temperature; 1582
Silver-zinc cells, performance, wet-stand test; 1765
Silver-zinc cells, physical characteristics; 1645
Silver-zinc cells, primary; 3, 7, 10, 64, 69, 72, 166, 372, 376, 405, 423, 432, 651, 700, 732, 735, 1474, 1965, 2060
Silver-zinc cells, primary button; 797
Silver-zinc cells, primary, review; 1294
Silver-zinc cells, primary, space application; 1528
Silver-zinc cells, primary, with varying electrolytes; 1616
Silver-zinc cells, reactions; 518, 614, 640, 707, 1653, 1906
Silver-zinc cells, sealed; 888, 968, 1100, 1137
Silver-zinc cells, sealed, capacity ratings; 662, 663, 898, 1399, 1801, 1868
Silver-zinc cells, sealed, general status; 1250, 1344
Silver-zinc cells, sealed, review; 1294
Silver-zinc cells, shock analyses; 662, 866
Silver-zinc cells, stress analysis; 662
Silver-zinc cells, vented; 970, 1626
Silver-zinc cells, vented, design; 1749
Silver-zinc cells, voltage plateau; 1593
Silver-zinc missile power supplies, 95 volt; 790, 1474
Silver-zinc missile power supplies, 95 volt, 200 watt hour; 886
Silver-zinc missile power supplies, 300 volt, 8500 watt; 1722, 1723, 1724
Silver-zinc missile power supplies, 1500 volt, 750 watt hour; 1721, 1722
Silver-zinc plates, properties after sterilization (135 C); 1256
Sintered body, micropored; 776, 3051, 3087
Sintered electrodes, cadmium; 1511, 3050, 3380, 3381, 3392
Sintered electrodes, organic electrolytes; 1321
Sintered nickel plaques, impregnation procedures; 1551, 1761, 3265, 3380, 3381
Sintered structures, porous, fabrication; 1484, 3208, 3381
Sodium additions, cadmium oxide; 3295
Sodium amalgam-air cells, low storage efficiency; 1355
Sodium amalgam electrodes, effects of metal concentration; 1331
Sodium amalgam electrodes, studies; 2075
Sodium electrodes; 1008, 1885, 1905
Sodium electrodes, high temperature batteries; 1076, 1077
Sodium fluoroborate solutes; 948
Sodium halides, solubility in organic solvents; 1228
Sodium hexafluorophosphate solutes; 1885, 2108, 2112
Sodium hydroxide electrolytes; 238, 367, 408, 409, 3369
Sodium hydroxide, electrolytic conductivity; 1148
Sodium ion reduction; 2051
Sodium-metal chloride high temperature batteries; 1076
Sodium, properties in organic solvents; 1232
Sodium reaction with organic solvents; 1107

Sodium-sulphur cells; 1855, 1885
Sodium-sulphur cells, patents; 1814
Sodium tetrafluoroborate, heat of formation; 1164
Sodium thiocyanate solutes, ammonia; 1277
Sodium/tin alloy-nickel cells, patents; 1814
Sodium trifluoroacetate solvents, preparation; 1248
Sodium trifluoromethanesulfonate-lithium perchlorate electrolytes; 1248
Sodium trifluoromethanesulfonate solvents, properties; 1248, 1728
Solar absorptance, satellites; 1065
Solar arrays; 678
Solar cell arrays; 313, 586
Solar cell batteries, status; 1286
Solar cells; 657
Solar cells, bibliography; 965
Solar energy collectors; 1287
Solar space power, review; 1529
Solar-thermal systems; 1287
Solenoid timer apparatus; 465
Solid electrolyte cells, state-of-the-art; 1494, 1855
Solid electrolyte primary cells; 4, 2060
Solid electrolyte systems, patents; 1814
Solid electrolytes, high temperature batteries; 1078, 1909
Solid state batteries, designs; 1304
Solid state electrodes, reactions; 591
Solvation calculations, water, propylene carbonate; 1679
Solvation coefficients, organic electrolytes; 1542
Solubility (See also specific elements or compounds)
Solubility, alkali chlorides; 2049
Solubility, cadmium chloride in formamide; 1939
Solubility, cadmium oxide; 340, 456, 908, 1334
Solubility, inorganic materials in acetonitrile; 1212
Solubility, organics; 1223, 1795, 1852
Solubility products, silver chloride, effects of temperature; 1157
Solubility products, silver chloride, effects of water; 1157
Solubility, silver oxide in potassium hydroxide; 518, 551, 554, 662, 687,
785, 843, 866, 1068, 1147, 1205, 1331, 1365
Solubility, zinc hydroxide in other metal hydroxides; 731
Solubility, zinc hydroxide in potassium hydroxide; 684
Solubility, zinc oxide in other metal oxides; 731
Solubility, zinc oxide in potassium hydroxide; 357, 536, 662, 684, 745, 866,
879, 1486
Solutes, organic electrolytes, analyses; 492, 984, 1295
Solutes, solubility measurements; 1023, 1024
Solutes, solubility in organic solvents; 1014
Solution concentration feedback mechanism; 1413
Solution equilibria, non-aqueous; 1228
Solvation calculations, water, propylene carbonate; 2049
Solvents for organic electrolytes, properties (See also Organic solvents); 991
Solvent-solute atmosphere screening, liquid ammonia batteries; 1093

Sound velocity, propylene carbonate; 1024
Soxhlet extractor, design and operation; 1980
Space batteries, evaluation, summary of experimental conditions; 1249
Space batteries, evaluation, test methods; 1249
Space guidance components; 1173
Space missions, battery requirements; 511, 643
Space orientated applications; 1294
Space power systems, design; 1294
Space power systems, discussion; 1530, 3055
Space power systems, performance; 193, 1803
Space power systems, review; 812, 1528
Space power systems, selection; 1528
Space power systems, solar energy; 1529
Space power systems, thermoelectric, design; 1532
Space power systems, weight distribution; 1804
Space station batteries, 2106
Spacecraft applications; 820, 920
Spacecraft batteries; 657, 870, 911, 1290, 3019, 3056
Spacecraft batteries, acceptance tests; 1433, 1434, 1435, 1436, 1437, 1438
Spacecraft batteries, evaluations; 47, 72, 89, 101, 189, 190, 193, 249, 494, 506, 511, 615, 660, 683, 693, 694, 701, 710, 806, 921, 1069, 1367, 1482, 1655, 3019, 3057, 3058, 3105
Spacecraft batteries, operational requirements; 1729
Spacecraft batteries, test data; 803, 805, 1468
Spacecraft power sources; 17, 29, 30, 33, 39, 67, 72, 87, 89, 95, 97, 101, 102, 193, 204, 233, 252, 269, 293, 332, 333, 335, 358, 364, 369, 376, 382, 387, 432, 433, 470, 471, 472, 482, 494, 500, 506, 511, 520, 529, 542, 561, 586, 615, 621, 631, 642, 659, 669, 670, 674, 678, 694, 699, 3018, 3019, 3027, 3160
Spacecraft power sources, non-electrochemical; 435
Spacecraft power systems; 758, 811, 1661, 3075, 3056, 3160, 3173
Spacecraft, surface friction and zero gravity heat transfer experiments; 511
Spacecraft system requirements; 511, 670
Spacecraft, thermal and power characteristics, analog simulation; 461
Specific gravity, Leclanche' cells; 462, 579
Specific gravity, nickel-cadmium cells; 1100
Specific gravity, silver-zinc cells; 464
Specific heat, aqueous chloride electrolytes; 1357
Specific heat, Leclanche' cells; 462, 579
Specific heat, lithium-silver chloride cells; 940
Specific heat measurements; 462, 1637
Specific heat, nickel-cadmium cells; 462, 650, 1100, 2097
Specific heat, silver-zinc cells; 464, 1100
Specific resistance measurements (See also Resistivity); 1095, 1921
Specification, aircraft batteries; 2179
Specification, batteries; 2061
Specification, Leclanche' cells; 1944
Specification, nickel-cadmium cells; 914, 1362, 1516, 1517, 1861
Specification, silver-cadmium cells; 1391, 1518

Specification, silver plates; 1499
Specification, silver-zinc cells; 1518
Specification, zinc oxide plates; 1500
Spectrochemical analysis, copper chloride electrodes; 1177
Spectrochemical analysis, lithium electrodes; 1177
Spectrophotometric analysis, cadmium solutions; 456
Speedlight batteries; 119
Spin resonance techniques, battery application; 1756
Stabilization, nickel electrodes; 37, 192, 200, 201, 475, 626
Stabilizer cells, special design; 909
Stabistors, electrical evaluation; 187, 188, 202, 203, 308, 1453
Stabistors, fabrication; 186, 187, 203, 366, 628, 1453
Stabistors, thermal evaluation; 186, 187, 203, 337, 366, 963, 1453, 1725
Stacked screens; 1896
Standard cells; 2060
Standard potentials, alkali metal halides in organic solvents; 1312
Standardization, batteries; 167, 301, 417, 466
State-of-the-art, auxiliary electrodes, development; 877
State-of-the-art, batteries; 193, 250, 269, 420, 582, 640, 643, 700, 796, 3120
State-of-the-art, fuel cells; 796
State-of-the-art, hermetic seals; 787
State-of-the-art, silver-zinc cells; 1648
State-of-charge; 34, 94, 98, 397, 398, 444, 495, 531, 544, 584, 622, 623
State-of-charge, cadmium electrodes; 1776, 1977, 3058, 3396
State-of-charge, computer calculation; 2068
State-of-charge, current sharing method; 1874, 1987
State-of-charge, device; 1987, 1992
State-of charge, effects on electrode composition; 183, 184, 185, 192, 200
State-of-charge, effects of temperature; 1198
State-of-charge, mercury cells; 1605, 1737, 1738
State-of-charge, lead-acid cells; 1929, 2005
State-of-charge, nickel-cadmium cells; 477, 486, 1317, 1548, 1549, 1550, 1629, 1809, 1919, 1929, 1986, 1987, 2003, 3058, 3160, 3396
State-of-charge, nickel electrodes; 1776
State-of-charge, silver-zinc cells; 1929
State-of-charge, zinc electrodes; 1139
Statistical analysis, organic half-cell screening tests; 1098
Statistical design, organic half-cell screening tests; 1097
Statistical designed battery experiments; 368, 375, 447, 3398
Steam retention, silver-zinc batteries; 230
Sterilization effects, cellophane separators; 1369
Sterilization effects, electroformed zinc plates; 1369
Sterilization effects, nickel-cadmium cells; 242, 441, 1281, 1432
Sterilization effects, silver-cadmium cells; 496
Sterilization effects, silver oxide plates; 1369
Sterilization effects, silver-zinc cells; 208, 209, 210, 436, 437, 450, 484, 490, 1422
Sterilization procedures; 597
Sterilization techniques; 662

Sterilization tests, separators, silver-zinc cells; 1170, 1398
Sterilization time, effects; 1137
Sterilized nickel plates, X-ray diffraction studies; 1051
Sterilized sealed cells, performance; 866, 888
Sterilized silver-zinc cells, stand-float performance; 1422, 1588
Sterilizing mixture, addition of zirconia; 1170, 1398
Stoichiometric changes, electrodes; 675
Stoichiometry, nickel hydroxides; 444
Storage batteries, construction; 848, 914, 3102
Storage effects, batteries; 534, 1302
Storage effects, mercury cells; 1738
Storage life, lithium-copper fluoride cells; 1329
Storage life, silver-zinc cells; 1626
Storage methods, nickel-cadmium cells; 1496, 2136, 3124, 3390, 3408
Storage methods, nickel-cadmium cells, results of; 1497, 3124, 3390, 3408
Storage tests, nickel-cadmium cells; 2136, 3124, 3390, 3408
Stress analysis, cell cases; 793
Stress level, definition; 1152, 2132, 2133, 3237
Stressed cycling tests; 1226
Strontium-90 powered devices; 1814
Strontium, properties in organic solvents; 1232
Structural changes from gas pressure; 2130
Submarine batteries, test circuits; 1195
Sulfide electrodes; 1375, 1540
Sulfide electrodes, positive; 1556
Sulfolanes; 1542, 1742
Sulfolanes, physical properties; 1742
Sulfolanes, solvents; 1261, 1852
Sulfolanes, solvents, voltage stability; 1604
Sulfur additions, electrolytes; 228, 278
Sulfur-carbon electrodes, liquid ammonia batteries; 1105
Sulfur-carbon electrodes, polarization; 1185
Sulfur dioxide absorption; 1953
Sulfur dioxide batteries; 1533, 1924
Sulfur dioxide cells, secondary; 2002
Sulfur dioxide-ethylene carbonate solvents; 1533
Sulfur dioxide-lithium-aluminum halide electrolytes; 1008
Sulfur dioxide-sodium-aluminum chloride electrolytes; 1008
Sulfur dioxide solvents; 1008, 1533
Sulfur electrodes, ammonia electrolytes; 1277
Sulfur electrodes, corrosion studies; 2092
Sulfur electrodes, effects of hydrogen sulfide and ammonium ion; 1189
Sulfur electrodes, liquid ammonia batteries; 1189
Sulfur electrodes, polarization; 1133
Sulfur electrodes, primary cell; 1885
Supercharging; 135
Surface active agents, zinc electrodes; 968, 1486
Surface area effect; 2021
Surface area measurements, BET method; 56, 272, 826, 1385, 1572, 2088, 3365

Surface area measurements, cadmium electrodes; 243, 272, 493, 760
Surface area measurements, double layer capacity method; 1572
Surface area measurements, lead dioxide electrodes; 493, 1572
Surface area measurements, metal oxides; 2023
Surface area measurements, nickel electrodes; 56, 243, 272, 445, 476, 919, 1385
Surface area measurements, nickel fluoride electrodes; 971, 976, 977, 1184
Surface area measurements, potentiostatic techniques; 1201
Surface area measurements, silver electrodes; 272, 493, 521, 692, 752, 1572
Surface area measurements, zinc electrodes; 493, 731, 748, 1572
Surfactants (See also Surface active agents); 518, 580, 731
Surfactants, silver-zinc cells; 750
Surge current data; 561
Switching circuits, dual SCR; 628
Synchronous orbit battery cycler; 1748
Synchronous orbit, simulated; 1100, 1744, 1971, 3013, 3144, 3167, 3411, 3412
Synchronous orbit, testing; 1655, 1967
System analysis, 6-volt batteries; 1138

T

Tab welds, improved; 2044, 3221
Tafel data, liquid ammonia electrolytes; 1093
Tape recorder regulators; 586
Tear-down analysis, nickel-cadmium cells; 1258, 1410
Tear-down analysis, silver-zinc cells; 1473
Teflon additions, cadmium electrodes; 1837
Teflon additions, zinc electrodes; 1406, 1771
Teflon coating, aluminum cell cases; 1208, 1209
Teflon transparent films; 1287
Tellurium additions, carbon electrodes; 1887
Tellurium additions, fused salt electrolytes; 188
Tellurium additions, lead electrodes; 1959
Tellurium amalgam electrodes, studies; 2075
Telstar orbiting vehicle batteries; 17, 95, 293
Temperature coefficient, EMF, lead-acid cells; 1174, 1637
Temperature coefficient, EMF, nickel-cadmium cells; 51, 1100, 1637
Temperature coefficient, EMF, silver-zinc cells; 1637
Temperature control, nickel-cadmium cells; 1524, 1990, 2074, 2097, 2158
Temperature control, satellite batteries; 2107
Temperature distribution in slabs, three-dimensional analysis; 1054
Temperature effects, cadmium electrodes; 1915, 3365
Temperature effects, lithium-copper fluoride cells; 987
Temperature effects, lithium-silver chloride cells; 1503
Temperature effects, nickel-cadmium cells; 1524, 1644, 1727, 1842, 3011, 3013, 3014, 3287, 3384
Temperature effects, nickel-cadmium cells, shelf and cycle life; 544, 578, 606, 1220, 1655

Temperature effects related to cell failure; 549, 1100, 1637, 3082
Temperature gradients, nickel-cadmium cells; 332, 543, 579, 642, 650, 691, 1100, 3011, 3070
Temperature gradients, predictions; 782A
Temperature gradients, silver-zinc cells; 1468
Temperature histories, orbiting vehicle equipment; 462, 470
Temperature histories, satellite equipment; 1884
Temperature measurement techniques; 1101, 1172, 1869
Temperature profile, lithium-chloride cells; 1923
Temperature profile, spacecraft batteries; 1803
Temperature properties, aerospace cells; 2107
Temperature requirements, military; 1523
Temperature rise, calculated, silver-zinc cells; 790, 1468
Temperature rise, lithium-copper chloride cells; 1177, 1280
Temperature rise, maximum predicted, fuel cell batteries; 782B
Temperature rise, maximum predicted, nickel-cadmium cells; 782
Temperature rise, maximum predicted, silver-zinc cells; 782
Temperature rise, maximum theoretical, nickel-cadmium cells; 355
Temperature rise, nickel-cadmium cells; 641, 800, 1100, 1554, 1619
Temperature rise, silver-cadmium cells; 645
Temperature sensing battery regulator; 1619
Temperature sensing bridge networks; 628
Terminal charging voltages; 717
Terminal design, high rate cells; 1564
Terminal placement; 1918
Terminology, batteries; 211, 640, 1944
Test apparatus; 613, 709, 1195, 1294, 1651
Test conditions; 681, 683
Test control circuitry; 1141
Testers; 380, 477, 486, 622, 883
Testers, Vitro; 623, 1919
Testing programs, nickel-cadmium cells; 419, 486, 556, 604, 637, 681, 703, 1198, 1919, 2058, 3103, 3090, 3201
Testing programs, silver-cadmium cells; 419, 604, 681
Testing programs, silver-zinc cells; 208, 209, 419, 595, 604, 615, 681
Testing programs, spacecraft batteries; 309, 420, 683, 1294
Tetrabutylammonium Chloride, solubility in propylene carbonate; 1628
Tetrabutylammonium chloride, solutes; 1628, 2188
Tetrabutylammonium hydroxide solutes; 1505
Tetrabutylammonium perchlorate electrolyte; 2051
Tetrabutylammonium perchlorate solutes; 2188
Tetrachloroaluminete solutes; 972
Tetrachloro-p-benzoquinone electrodes, positive; 1940
Tetraethylammonium perchlorate electrolyte; 1908, 2051
Tetrafluoroborate solutes; 1155
Tetrahydrofuran-1,2, dimethoxyethane-lithium perchlorate electrolytes; 1386
Tetrahydrofuran electrolytes; 1760, 1775
Tetrahydrofuran perchlorate electrolytes; 1288
Tetrahydrofuran solvents; 1168, 1284
Tetrahydropyran electrolytes; 1775
Tetrahydropyran solvents; 1168

Tetramethylammonium hexafluorophosphate solutes; 990
Tetramethylammonium hydroxide solutes; 1268
Tetramethylbenzidine electrodes, negative; 2002
Tetramethyldi-imoniumdiphenoquinone diperchlorate electrodes, negative; 2002
Tetramethylene sulfoxide solvents; 1090, 1728
Tetramethylurea hexafluorophosphate electrolytes; 1030
Tetramethylurea solvents; 1241
Thallium additions, cadmium; 1140
Thallium additions, cadmium plates; 919
Thallium amalgam electrodes, reference, propylene carbonate; 1203
Thallium amalgam electrodes, studies; 2075
Thallium chloride electrodes, reference, propylene carbonate; 1263
Thallium hydroxide, solubility in water; 919
Thallos halides, solubility in propylene carbonate; 1263
Thermal analysis, magnesium batteries; 463
Thermal analysis, nickel-cadmium cells; 30, 184, 185, 332, 355, 369, 444, 461, 530, 543, 644, 777, 915, 1100, 1108, 1151, 1301, 1377, 1744, 1971
Thermal analysis, S/N 41-satellite; 1065
Thermal analysis, satellite subsystem; 2068
Thermal analysis, theoretical; 777, 1100
Thermal batteries; 3, 63, 64, 643, 658, 705, 880, 881
Thermal batteries, design; 1242
Thermal behavior, sealed cells; 1100, 3034
Thermal buckling, fuel cell batteries; 782A
Thermal capacitance analogs, cells; 1100
Thermal cells, primary reserve; 3, 63, 64
Thermal conductivities, estimation; 782
Thermal conductivities, Leclanche' cells; 462, 579
Thermal conductivities, nickel-cadmium cells; 1100, 1368, 1377, 3010
Thermal conductivities, silver-zinc cells; 464, 1100
Thermal conductivity; 1340, 1637, 3010
Thermal conductivity calculations; 2085
Thermal conductivity measurements; 543, 1220, 1341, 1627, 2085, 3010
Thermal control, batteries; 1744, 1971
Thermal control during orbits; 1527
Thermal control systems; 471, 472, 643, 3083
Thermal control systems, heat pipes; 1647, 3083
Thermal decomposition, cadmium salts; 1479
Thermal decomposition, cotton fabrics; 1872
Thermal decomposition, nickel nitrate; 426, 560
Thermal decomposition, silver dioxide; 422
Thermal decomposition, silver oxides; 560, 707, 891, 1633, 1634, 1654
Thermal decomposition techniques; 666, 675
Thermal design; 1341, 1637
Thermal design criteria, fuel cells; 782A
Thermal design criteria, nickel-cadmium cells; 578, 782, 1100, 1646, 2003, 2085
Thermal design criteria, satellite power systems; 461, 1809
Thermal design criteria, silver-zinc cells; 782, 1100

Thermal diffusivity, Leclanche' cells; 462, 579
Thermal diffusivity measurements; 462
Thermal effects, lithium-copper chloride cells; 1280
Thermal energy storage; 1287
Thermal impregnation process; 601
Thermal inertia, determination; 757
Thermal losses, nickel-cadmium cells; 1647
Thermal properties, cells; 579, 708, 1100, 1627
Thermal properties, primary cells; 1637
Thermal properties, secondary cells; 1637, 3034
Thermal protection relays; 605
Thermal resistance analogs; 1341
Thermal resistance analogs, cells; 642, 1100
Thermal resistance measurements; 1341
Thermal resistance networks; 1065, 1100, 1637, 2085
Thermal resistance, nickel-cadmium cells; 642, 1100, 1368
Thermal runaway; 49, 196, 549, 605, 3082
Thermal stability, cupric chloride and lithium electrodes; 1797
Thermal stability, lithium perchlorate solution; 1366
Thermal stability, organic cell components; 1284
Thermal stress aging, nickel-cadmium cells; 2020
Thermal stresses; 421
Thermal switches; 643
Thermal time constants; 1100
Thermal vacuum tests; 390
Thermionic power systems; 435, 1662
Thermionic power systems, bibliography; 965
Thermistor bridge power supplies; 650, 827
Thermistor sensing units; 827, 2096
Thermistors; 644, 883
Thermodynamic measurements, methods for aprotic solvents; 1124
Thermodynamic potentials, organic electrolytes; 1382
Thermodynamic properties, ion solvation; 1679
Thermodynamic properties, lead-acid cells; 120, 2093
Thermodynamic properties, lithium chloride cells; 1461
Thermodynamic properties, lithium halides; 1571
Thermodynamic properties, lithium hexafluoroaluminate; 1165
Thermodynamic properties, lithium iodide; 1492
Thermodynamic properties, lithium-silver chloride cells; 1119, 2110
Thermodynamic properties, lithium tetrafluoroborate; 1164
Thermodynamic properties, nickel-cadmium cells; 120, 650, 827, 1100, 2093
Thermodynamic properties, organic batteries; 1158
Thermodynamic properties, potassium tetrafluoroborate; 1164
Thermodynamic properties, sodium tetrafluoroborate; 1164
Thermodynamic values, chloride reactions; 1320
Thermodynamic values, electrodes; 1315
Thermodynamic values, fluoride reactions; 1320
Thermodynamic values, nickel oxide; 1694
Thermodynamic values, organic half-cells; 949

Thermodynamic values, oxide reactions; 1320
Thermoelectric power systems; 435, 1662
Thermoelectric power systems, bibliography; 965
Thermoelectric power systems, thermal model; 1532
Thermogravimetric analysis, cadmium plates; 1140
Thermogravimetric analysis, nickel-cadmium electrodes; 1630, 2093
Thermogravimetric analysis, nickel plates; 1140
Thermogravimetric analysis, separators; 661
Thermogravimetric analysis, silver oxide; 1654
Thermogravimetric analysis, silver plates; 560
Thermophysical properties; 1341
Thermophysical properties, sealed cells; 1100, 2007
Thermopile construction; 867
Thermoplastic resin separators; 158
Thin film batteries; 669
Thiocyanate complexes in dimethylformamide; 1743
Thiocyanate electrolytes; 2078
Thiourea additions, cadmium nitrate solutions; 1949
Third electrode sensors; 512
Third electrodes; 169, 204, 261, 326, 379, 606, 1067, 1824, 3168
Third electrodes, carbon-activated; 825, 865, 1139
Third electrodes, charge control; 1470, 2041, 3018
Third electrodes, silver amalgam; 1099
Third electrodes, silver-mercury catalyzed; 1406
Time constants, thermal analog circuits; 1100
Tin additions, alkaline electrolytes; 139, 721, 1304, 1904
Tin additions, silver oxide samples; 1593
Tin electrodes, preparation; 1689
Tin impurities, zinc electrodes; 502, 1250
Titanium alloy dry primary cells; 4
Titanium dioxide additions, cadmium electrodes; 2057
Titanium nitride electrode support; 1917, 2056
Titanium nitride plaques, preparation; 1625
Titanyl phosphate/polymer separators, properties; 1353
Torpedo batteries; 506
Tortuosity factor; 1288, 3148
Total pressure effects; 606
Tracer techniques, applied to silver migration; 711, 891
Tracer techniques, applied to zinc oxidation; 1205
Tracers, tritium, with zinc electrodes; 707
Trade-off studies, silver-zinc cells; 207, 213
Transducers; 558, 561
Transducers, operation tests; 595
Transducers, pressure, equipped cells; 717
Transfer coefficients; 3407
Transference measurements, propylene carbonate electrolytes; 951
Transference numbers (See Transport numbers)
Transformer design; 790A
Transient peak height; 46, 98, 198, 377
Transient pulse flow, fuel cells, analysis; 1844

Transistor failures, effects of high power dissipation; 886A
Transistor failures, effects of surge currents; 790A
Transistor overstress; 790A
Transistorized circuitry; 186, 187, 218, 774
Transition-metal oxides, polaron theory; 3328, 3329
Transport behavior, electrolyte solutions; 547, 555, 580, 813, 1653, 3369
Transport entropies; 550
Transport measurements; 1413, 1676
Transport numbers, acetonitrile; 1024
Transport numbers, dimethyl formamide; 1023
Transport numbers, lithium in butyrolactone; 1042, 1182
Transport numbers, lithium in propylene carbonate; 1119, 1491
Transport numbers, organic electrolytes; 974, 985, 1117
Transport parameters, organic compounds; 1577
Transport parameters, silver-zinc batteries; 1464
Trigram failure characteristic techniques; 728
Triode circuits; 625
Tritium tracers, nickel-cadmium cells; 1986
Tritium tracers, silver-zinc cells; 617, 707, 1205, 1654
Triton X additions, electrolytes; 1790
Triton X additions, silver oxide plates; 1790
Trivalent silver oxide; 1730
Tungsten-sodium hydroxide systems; 548
Turbomachinery, space power application; 1662
Types, definitions and descriptions, batteries; 582

U

U.K. satellite power systems; 252, 358, 369, 586
Ultrasonic impregnation; 1935, 3220
Ultrasonic welding, cover-to-case; 597, 735, 3001
Ultrasonics effects, nickel electrodes; 589
Ultrasonics effects, silver electrodes; 780, 824, 874, 1102, 1255, 1298
Ultrasonics effects, silver-zinc performance; 278
Unbalance, nickel-cadmium cells; 483
Underwater batteries; 80, 875
Uniformity, nickel-cadmium cells; 556, 607, 626, 4108, 3004
Uniformity, silver-zinc cells; 1390
Upside down cycle; 1528
Uranium-uranium trioxide cells, patents; 1814
Utilization factors; 899, 1949
Utilization factors, nickel electrodes; 1509

V

Vanadium electrodes, organic electrolytes; 982, 1305
Vanadium oxide electrodes, polarization; 1133
Vanadium pentoxide dry primary cells; 4
Vanadium pentoxide electrodes, organic electrolytes; 1016
Vapor pressures, organic electrolytes; 967
Vapor pressures, potassium hydroxide; 866
Variable charge time tests; 649
Variable current tests; 649
Variable voltage tests; 649
Vehicular applications, power source selection; 1813
Vehicular propulsion batteries; 1651, 1652, 2143
Venting, batteries; 644, 720
Vibration analyzers; 588
Vibration consoles; 588
Vibration tests, ammonia cells; 1053
Vibration tests, nickel-cadmium cells; 401, 1433, 1434, 1435, 1554, 1573, 1574
Vibration tests, silver-cadmium cells; 421
Vibration tests, silver-zinc batteries; 482, 561, 595, 597, 1468
Vicious cycles; 549
Viking spacecraft power source; 1801
Vinyl polymer separator materials; 661
Viscosity, aprotic solvents; 1562
Viscosity measurements, organic electrolytes; 1086, 1091, 1462, 1600
Viscosity, organic electrolytes; 943, 945, 947, 948, 971, 972, 1023, 1024, 1120, 1184
Viscosity, organic electrolytes containing sulfur; 1111
Viscosity, organic solvents; 1184
Voltage and amperage recording; 588
Voltage calculations; 321
Voltage characteristics, nickel-cadmium batteries; 186, 187, 188, 1440, 1655
Voltage, charging, terminal; 717
Voltage control, nickel-cadmium cells; 204, 218, 249, 1726
Voltage conversion-regulation system; 1420
Voltage cut-off; 202, 249
Voltage decay, nickel-cadmium cells; 48, 626, 650
Voltage efficiency, mathematical analysis; 1087
Voltage, end-of-charge; 447
Voltage-frequency converter; 2124
Voltage histograms; 803
Voltage limiter devices, two step type, silver-cadmium cells; 631, 714
Voltage measurement techniques; 1101
Voltage output, multiple; 586
Voltage overshoot; 454
Voltage regulation; 204, 233, 624, 1726

Voltage regulators, d.c. output; 586
Voltage rise time, silver oxide electrodes; 1789, 1790, 1791
Voltage sensor design; 1513, 1822, 2127
Voltage stabilization; 909
Voltage surges, silver-zinc batteries; 1468
Voltage sweep methods; 518, 1580, 2062
Voltage, uniform; 674
Voltammetry, alkaline electrolytes; 2040
Voltammetry, nickel fluoride electrodes; 1211
Voltammetry, organic electrolytes; 928, 1088, 1501, 1586, 1604, 1757
Voltammetry, organic positive electrodes; 1757
Voltammetry, screening of organic compounds in organic solvents; 1267
Voltammetry, screening tests in fused salt electrolytes; 1839
Voltammetry, screening tests in organic electrolytes; 492, 974, 978, 979, 980, 981, 982, 991, 992, 993, 1021, 1022, 1031, 1043, 1096, 1223, 1305
Voltammetry, solid electrodes in organic electrolytes; 1534
Volume analysis, silver-zinc cells; 207, 423, 1721, 1722, 1723
Volumetric analysis, nickel-cadmium cells; 793

W

Walden products, organic solute solutions; 1091, 1389
Water-activated batteries; 2061
Water additions, potassium hydroxide; 533, 595
Water additions, propylene carbonate; 1463
Water analysis, organic electrolytes; 1098, 1908
Water analysis, organic solvents; 1007, 1021
Water analysis, vapor phase chromatography; 995
Water contamination, organic electrolytes; 1020, 1021, 1224
Water content, organic electrolytes, effects on cathode solubility; 1180
Water, effects on lithium-moist air cell performance; 1240
Water, effects on organic electrolytes; 1123, 1134, 1153, 1288, 1305, 1509
Water formation, nickel-cadmium cells; 610
Water formation, nickel-iron cells; 851
Water-lithium complexes; 1224, 1288
Water loss through electrode pores; 1334, 1339
Water loss during heat sterilization; 888
Water loss during overcharge; 1364
Water loss rates, sealed cells; 2027, 3192
Water removal, nickel-cadmium cells; 610
Water vapor penetration, organic electrolyte cells; 989
Water vapor transmission, cell case materials; 1250
Water weight loss through sealed cases, silver-zinc cells; 1221, 1390
Watt hour meters, design and operation; 883, 1798
Watt hour meters, specifications; 1798
Watt hours per pound, sealed cells (See Energy densities, sealed cells)
Wave guide electrochemical cell, structure; 1784

Waxy electrolyte primary cells; 4
Weaving fabrication; 1896
Weight analysis, battery plates; 1799, 3383
Weight analysis, cadmium-oxygen cells; 1251
Weight analysis, high energy cells; 462, 506, 871
Weight analysis, liquid ammonia batteries; 1071
Weight analysis, lithium batteries; 959
Weight analysis, lithium cells; 1085, 1087
Weight analysis, lithium-copper chloride cells; 1177
Weight analysis, lithium-copper fluoride cells; 989
Weight analysis, lithium electrodes; 1089
Weight analysis, magnesium-air batteries; 1264
Weight analysis, magnesium-oxygen cells; 1251
Weight analysis, nickel-cadmium cells; 268, 462, 483
Weight analysis, organic electrolyte batteries; 462, 506, 871, 1028
Weight analysis, plastic battery as assembly; 1785
Weight analysis, silver-cadmium cells; 268, 462
Weight analysis, silver-zinc cells; 207, 268, 423, 462, 886, 888, 1474,
1721, 1722, 1723
Weight analysis, zinc-air cells; 494, 538
Weight calculations, cadmium-oxygen cells; 1067
Weight calculations, nickel-cadmium batteries; 802, 3020
Weight-to-capacity correlations, nickel-cadmium electrodes; 1773
Weight changes, nickel plates; 916
Weight efficiency, mathematical analysis; 1087
Weight loss during cycling, nickel-cadmium cells; 793
Wetting agents, lead-acid cells; 1281
Wheatstone bridge, modified; 658
Wicking materials; 662, 842, 866, 1472
Wind-and-sinter fabrication; 1896

X

X-ray diffraction studies, iron electrodes; 1879
X-ray diffraction studies, nickel-cadmium electrodes; 1630, 3371
X-ray studies, cadmium electrodes; 48, 371, 540, 3248, 3335, 3353, 3354, 3365, 3367,
3371, 3406
X-ray studies, copper fluoride electrodes; 994
X-ray studies, iron-nickel alloys; 594
X-ray studies, magnesium; 3354
X-ray studies, nickel-cadmium cells, failure analysis; 371
X-ray studies, nickel electrodes, cobalt additions; 1257
X-ray studies, nickel electrodes, cycling effects; 182, 184, 185, 192, 201,
243, 443, 475, 540, 647, 675, 901, 905, 1273, 1275, 3371, 3406
X-ray studies, nickel electrodes, sterilization effects; 919, 1051, 1140, 1259
X-ray studies, nickel electrodes, temperature effects; 48, 444, 540, 902
X-ray studies, nickel fluoride electrodes; 1184
X-ray studies, and SEM, cadmium electrodes; 2088
X-ray studies, silver electrodes; 415, 521, 624, 752, 866
X-ray studies zinc electrodes; 535, 624, 662, 866, 3354

Y

Yardney battery P/N 61403; 595
Ytterbium, properties in organic solvents; 1232
Yttrium additions, silver oxide samples; 1593
Yttrium-doped electrodes; 1794

Z

Zamboni piles; 4
Zener diode circuits; 524, 698
Zeolites, high temperature batteries; 1076, 1077, 1078, 1353
Zero gravity test programs; 1141, 1226, 1381, 3008, 3073
Zinc additions, cadmium electrodes; 256, 407
Zinc agglomeration, negative active materials; 731, 750, 1426
Zinc-air cells, performance characteristics; 2025
Zinc-air cells, rechargeable; 538, 879, 887, 1167, 1176, 1335, 1827, 1882, 2042, 2080, 2144
Zinc-air cells, recharging; 1830, 1832
Zinc-air cells, review; 1286, 1355, 2098
Zinc-alkali manganese dioxide primary cells; 1344, 2061
Zinc-alkali mercuric oxide primary cells; 1344
Zinc amalgam electrodes, studies; 1139, 2066, 2075
Zinc, ammonia precipitation; 560
Zinc-ammonium chloride-manganese dioxide primary cells; 1344, 2061
Zinc anode surface disintegration; 744
Zinc anodes, deposition of silver; 891
Zinc, anodic oxidation in alkaline solutions; 707, 741, 891, 1205
Zinc behavior in varying potassium hydroxide concentrations; 1486
Zinc-bismuth couple, potassium hydroxide; 624
Zinc-bromine batteries, patents; 1814
Zinc-bromine secondary cells; 773
Zinc-cadmium couple, potassium hydroxide; 624
Zinc-carbon cells (See Leclanche' cells)
Zinc cells, alkaline, rechargeable; 895, 1764
Zinc chloride additions, aluminum powder; 1484
Zinc-chlorine primary cells; 7, 10
Zinc-cobalt alloy electrodes, passivation studies; 356
Zinc cobwebs, formation; 1591
Zinc compacts, fabrication; 899
Zinc consumption; 748
Zinc-copper cells; 2060
Zinc-copper cells, patents; 1814
Zinc crystallography; 786, 1250
Zinc dendrites, electrocrystallization, 2086
Zinc dendrites, formation and growth; 439, 522, 632, 679, 746, 747, 767, 768, 786, 804, 1591, 1906, 2086
Zinc dendrites, growth modes (early stages); 746

Zinc dendrites, penetration of separators; 713, 1296, 1297, 1878
Zinc dendrites, propagation rate; 768, 2086
Zinc dendrites, shorting, alkaline cells, prevention; 1764, 1830, 1930, 1961, 2125
Zinc dendrites, types; 768
Zinc densification, retarded; 750
Zinc deposit morphologies; 786
Zinc deposition, horizontal and vertical electrodes; 1739
Zinc deposition by interrupted current sources; 747
Zinc deposition, rotating disk electrodes; 804
Zinc deposition studies; 651
Zinc diffusion separators, screening; 1731
Zinc disintegration during electrolysis; 535
Zinc dissolution, alkaline media; 632, 741, 745, 866, 1590, 1796, 1820, 2129
Zinc dissolution, mercury; 707
Zinc dissolution, nitrate solutions; 535, 744
Zinc dry cells, patents; 1814
Zinc dry cells, status; 2098
Zinc effect on nickel electrodes; 1469
Zinc, electrochemical behavior; 492, 518, 536, 684
Zinc electrode reaction mechanisms; 1064
Zinc electrodes, absorption of organic materials; 731B, 1202C
Zinc electrodes, ammonia electrolytes; 1478
Zinc electrodes, anodic behavior; 1602
Zinc electrodes, anodic and cathodic processes; 518, 536, 1486
Zinc electrodes, anodic discharge, polarization; 1674
Zinc electrodes, anodic processes; 740, 1194
Zinc electrodes, asbestos fiber-containing; 1541
Zinc electrodes, binders; 1250
Zinc electrodes, bonded; 1762
Zinc electrodes, cathodic processes; 740
Zinc electrodes, cell failure; 234, 235
Zinc electrodes, cellophane-wrapped; 795
Zinc electrodes, charge acceptance; 1194
Zinc electrodes, charge characteristics; 1419
Zinc electrodes, charging characteristics; 466, 1893
Zinc electrodes, chronopotentiometric studies; 1331
Zinc electrodes, concave; 865, 1508
Zinc electrodes, contamination; 518, 1653
Zinc electrodes, contoured; 1099, 1139, 1289, 1302, 1406, 1665
Zinc electrodes, corrosion behavior in potassium hydroxide; 341, 1820
Zinc electrodes, corrugated foil; 227
Zinc electrodes, discharge capacity; 795
Zinc electrodes, discharge characteristics; 1419
Zinc electrodes, dissolution mechanism; 1602, 1988
Zinc electrodes, dissolution rates; 1202A, 1426C
Zinc electrodes, doped; 583
Zinc electrodes, double grids; 238
Zinc electrodes, effects of amalgamation; 357, 490, 505, 515, 518, 535, 707, 878, 1138, 1194, 1202A, 1426C, 1486, 1653, 1994, 2015

Zinc electrodes, effects of carbonate; 1859, 1988
Zinc electrodes, effects of sterilization; 1417
Zinc electrodes, effects of surfactants; 503, 504, 505, 968, 1426, 1426A, 1653
Zinc electrodes, effects of variables; 518
Zinc electrodes, efficiency, effects of porosity; 1192
Zinc electrodes, electrical characteristics; 1452
Zinc electrodes, electrochemical behavior in alkaline media; 551, 742, 1064, 1486, 1592, 1815, 1988, 1994
Zinc electrodes, electrochemical oxidation; 843
Zinc electrodes, electron microscopy; 1202B
Zinc electrodes, evaluation in silver-zinc secondary batteries; 1426A
Zinc electrodes, exchange current; 2014
Zinc electrodes, extended edges; 1139, 1289, 1302, 1406
Zinc electrodes, fabrication; 731, 1202, 1377, 1426, 1508, 1961, 2134
Zinc electrodes, failed; 1426C
Zinc electrodes, fiber-containing; 1099, 1406
Zinc electrodes, film composition; 1699
Zinc electrodes, film formation; 1567, 1699, 1739, 1820, 1904, 1994
Zinc electrodes, graphite layer; 1961
Zinc electrodes, gravity effects; 1381
Zinc electrodes, hydrogen evolution; 1204, 1904
Zinc electrodes, impurities, effects; 1202B
Zinc electrodes, irradiation effects; 795
Zinc electrodes, leached, pressed, and sintered; 1901
Zinc electrodes, lead sulfide additions; 2006
Zinc electrodes, long life; 825, 865, 1099, 1302, 1406
Zinc electrodes, loss of capacity; 1354
Zinc electrodes, mechanisms for anodic oxidation; 741
Zinc electrodes, microscopic study; 1417, 1636, 1699, 1904
Zinc electrodes, organic electrolytes; 492, 979, 981, 982, 1022, 1103, 1321
Zinc electrodes, palladium-alumina additions; 502
Zinc electrodes, passivation; 240, 241, 535, 684, 731, 743, 1175, 1202A, 1426C, 1486, 1605, 1796, 1820, 1859, 1833, 1988
Zinc electrodes, physical characteristics; 1452, 1882
Zinc electrodes, planar; 748
Zinc electrodes, plastic bonded; 1293, 1588
Zinc electrodes, polarization; 1323
Zinc electrodes, polarization studies; 865, 1204, 1486
Zinc electrodes, polyvinyl alcohol-wrapped; 1892
Zinc electrodes, porous; 493
Zinc electrodes, powdered; 695
Zinc electrodes, powder-gel type; 1541
Zinc electrodes, preparation; 208, 251, 363, 571, 662, 1340, 1426A, 1762, 1771, 1815, 1882, 2169, 2170, 2182, 2186
Zinc electrodes, pressed; 1762
Zinc electrodes, pretreatment; 1202A, 1426C
Zinc electrodes, primary, corrosion behavior in potassium hydroxide; 1304
Zinc electrodes, primary, polarization studies; 1304

Zinc electrodes, processes; 596
Zinc electrodes, processes in potassium hydroxide; 740
Zinc electrodes, reaction mechanisms; 2145
Zinc electrodes, rechargeable; 694, 1296
Zinc electrodes, rechargeable cells; 748
Zinc electrodes, rotating disk studies; 1602
Zinc electrodes, shape changes; 452, 515, 825, 1099, 1297, 1364, 1473, 2067
Zinc electrodes, shelf life of one year; 1302
Zinc electrodes, silver contamination; 518
Zinc electrodes, sintered; 1452
Zinc electrodes, sintered, preparation; 1192, 2159
Zinc electrodes, stability; 251
Zinc electrodes, surface area measurements; 731, 1202A, 1426A
Zinc electrodes, surface studies; 1193, 1426C, 1994
Zinc electrodes, surfactant additions; 1202
Zinc electrodes, surfactants, effects; 1202A
Zinc electrodes, transfer coefficient; 2014
Zinc electrodes, trapping materials; 1764
Zinc electrodes, utilization coefficient; 695, 1882
Zinc electrodes, weight loss; 624
Zinc fluoride electrodes; 1022
Zinc, half wave potential; 765
Zinc hydroxide, dehydration reaction; 741
Zinc hydroxide, separation from zinc metal; 1590
Zinc hydroxide, solid phase formation; 741
Zinc ion adsorption techniques; 2023
Zinc ion diffusion rates; 1055, 1713
Zinc-iron alloy electrodes, passivation studies; 356
Zinc-lead dioxide primary reserve cells; 7, 10
Zinc-manganese alkaline secondary cells; 885
Zinc-manganese alloys, passivation studies; 356
Zinc-manganese dioxide dry cells; 7, 118, 885, 2060
Zinc-mercuric oxide cells; 2060
Zinc-mercuric oxide batteries; 643, 1901
Zinc-mercuric oxide cells; 1192
Zinc-mercuric oxide cells, space applications; 1528
Zinc-mercuric oxide dry cells; 7, 151
Zinc-mercury-carbon primary cells; 64, 118
Zinc migration; 232, 233, 324, 331, 357, 412, 413, 452, 515, 684, 878, 2067, 3073
Zinc-nickel alloy electrodes, passivation studies; 356
Zinc-nickel secondary cells (See Nickel-zinc batteries)
Zinc oxidation mechanisms; 1205
Zinc oxide, additions, nickel-cadmium cell electrolytes; 392, 1680
Zinc oxide, additions, silver-zinc cell electrolytes; 580
Zinc oxide, adsorption; 1731
Zinc oxide, diffusion; 749, 1510, 1906
Zinc oxide, dissolution, potassium hydroxide; 518, 632, 745, 866, 1796, 2013
Zinc oxide, effects of silver oxide solubility; 1365
Zinc oxide, electrolytic production; 2013

Zinc oxide films, thickness, effects of potential variations; 743
Zinc oxide films, transport kinetics; 743
Zinc oxide hydration; 617
Zinc oxide, permeation rates in separators; 789
Zinc oxide, physical properties; 342
Zinc oxide, precipitation, potassium hydroxide; 500
Zinc oxide slurries; 572
Zinc oxide solubility, in potassium hydroxide; 357, 536, 662, 684, 745, 866, 879, 1486
Zinc oxide weight versus cycle life of silver-zinc cells; 1250
Zinc oxides, characterization; 731A, 1426A
Zinc oxides, doped; 731A
Zinc oxides, methods of manufacture; 1426A
Zinc oxides, overgrowth sites; 731, 1426
Zinc oxides, particle size and morphology; 1426
Zinc oxides, preparation; 731A
Zinc-oxygen battery systems; 693, 1138
Zinc-oxygen cells; 494, 523, 659, 694, 700, 1143, 1448, 2060
Zinc-oxygen cells, design; 1138, 2048
Zinc-oxygen cells, cycling data; 1541
Zinc-oxygen cells, performance; 523, 659, 1541
Zinc-oxygen cells, rechargeable; 694, 1057, 1296, 1297, 1472, 1541, 1663, 2145
Zinc-oxygen cells, space application; 1528z
Zinc-oxygen cells, space vehicle applications; 1138
Zinc-oxygen reaction; 672
Zinc-oxygen systems; 659
Zinc passivation; 731, 748
Zinc penetration, separators; 324, 522, 537, 624, 661, 738, 749, 765, 766, 767, 789, 804, 1052, 1354, 1906, 2005
Zinc penetration, separators, rates; 1203, 1426E, 1431, 1731
Zinc plates, acid treated; 899
Zinc plates, chemical characteristics; 1290, 1648
Zinc plates, design data; 1665
Zinc plates, design, wedge shaped; 1838
Zinc plates, discharge characteristics; 1202D
Zinc plates, formation; 651
Zinc plates, high surface area; 1575
Zinc plates, physical characteristics; 1290, 1601, 1648
Zinc plates, specifications; 1388
Zinc plates, teflonated; 1290, 2001
Zinc powders, sintered, pore size distribution; 1192
Zinc precipitates, alkaline solutions; 1654
Zinc precipitates from potassium hydroxide, preparation; 785
Zinc primary cells; 225, 674
Zinc, radioactive; 271, 324
Zinc reaction products, characterization; 788
Zinc salts, electrochemical formation; 1193
Zinc sedimentation; 452, 453
Zinc-silver couple, potassium hydroxide; 624

Zinc-to-silver ratio; 825, 1338
Zinc solubility, potassium hydroxide; 232, 634, 751
Zinc, spongy, formation; 1591
Zinc systems, organic electrolytes; 1305
Zinc, teflon coated; 825, 865, 1099, 1139, 2066
Zinc-tin couple, potassium hydroxide; 624
Zinc utilization; 693
Zinc whiskers, deposition; 804
Zinc, zero gravity effects on discharge; 352
Zinc-zinc amalgam system, electrochemistry; 1426B
Zincate, absorption isotherms for separators; 765, 766, 767, 897
Zincate, absorption in separators; 804
Zincate, adsorption on separators; 1066, 1303
Zincate, concentration in cellulose separators; 897
Zincate, diffusion in potassium hydroxide; 760
Zincate, diffusion rate; 1170
Zincate, diffusion rate in potassium hydroxide, 804
Zincate, diffusion rate through separators; 1398
Zincate, diffusion in separators, 767, 804
Zincate, distribution coefficients; 765, 766, 804
Zincate, ion concentration; 1883
Zincate ion migration; 1640
Zincate, ions, sizes in potassium hydroxide; 1202, 1426D
Zincate, reaction mechanisms; 2129
Zincate solutions, polarography; 1200
Zincate solutions, supersaturated; 1486, 2013
Zincate trapping, potassium hydroxide; 751
Zincate-zinc exchange; 2613
Zincate-zinc oxide exchange; 2013
Zirconia additions, zinc electrodes; 1452
Zirconia electrolytes; 1909
Zirconium oxide separators; 1477
Zirconium reinforcement, silver electrodes; 1422, 1588

AUTHOR INDEX TO BATTERY ABSTRACTS
B-1 through B-2189, TBC 3201 and on

A

Abbott, Helen M.; 301
Abens, Sandors G.; 927, 960, 1000, 1014, 1015, 1050, 1073, 1103, 1104, 1106
1155, 1210, 1227, 1483, 1927
Ackermann, Karl; 172, 469, 667, 1983
Ackermann, Roland; 215, 528
Adams, L.M.; 764, 1361, 1400, 1414, 1488, 1640
Adams, Mark F.; 1357
Adams, Ralph N.; 1025, 1558
Adler, Robert W.; 928, 944, 1030, 1088
Adubifa, A.; 2140
Afanos'ev, B. N.; 3308
Agruss, Bernard; 1005, 1651, 1652, 1813
Aguf, I.A.; 1920
Ahrens, A.F.; 3160
Aia, Michael A.; 444, 675
Aikens, D.A.; 3145
Albrecht, F.; 1219
Aleshkevich, S.A.; 668
Alfelt, Lars Goran; 907, 1740
Alfredson, K.; 538
Alliegro, F.; 36, 39
Allvey, G.W.; 422
Almerini, Achille L.; 1664, 2104
Alt, H.; 1943
Alwitt, Robert S.; 1040
Amey, Ralph L.; 1584
Amiet, Bernard Paul Louis; 1761
Amlie, R.F.; 350, 1091
Amsterdam, Richard E.; 186, 157, 188, 203, 311, 337, 366, 628, 699
Andelman, J.B.; 93
Anderson, W.G.; 1077, 1078
Ando, Koji; 1063
Andrews, A.W.; 1939
Andryushchenko, F.K.; 3271
Angell, C.A.; 813
Antikainen, P.J.; 778
Anton, A.M.; 2034
Antonenko, P.A.; 3260, 3261, 3277, 3278, 3314, 3321, 3324
Apelt, Armin O.; 309, 683
Apgar, G.M.; 395, 542
Appelt, K.; 3405, 3406
Arcand, George Myron; 560, 617, 671, 707, 785, 843, 891, 1204, 1205, 1330, 1331
1423, 1466, 1633, 1634, 1654, 1986, 2075
Argue, G.R.; 239, 1611, 1612
Arkhangel'skaya, Z.P.; 808

Armitage, D.A.; 1939
Arms, J.T.; 329
Armstrong, George M.; 1053, 1092, 1105, 1657
Armstrong, John; 1960
Armstrong, R.D.; 1970, 3297, 3316, 3317, 3333, 3338, 3339
Aronson, Robert R.; 1825
Arouete, S.; 747, 768
Arouete, S.; 747, 768
Arrance, Frank C.; 208, 450, 571, 572, 876, 964, 1815, 1826, 1831, 2045, 2126, 2150, 2159, 2161, 2168
Ashcroft, T.B.; 1872, 3223
Athearn, L.F.; 995, 996, 1947, 2050
Atkinson, G. Scott; 255
Augustynski, A.; 1592
Aulin, Sven Olof; 553
Austin, C.M.; 206, 394, 539
Austin, I.a.; 3329
Austin, L.G.; 516, 1576, 1674, 1916, 2062, 3387
Aydeev, N.Ya.; 3242
Azim, A.A.Abdul; 3369
Azulay, M.; 910

B

Baars, Ernst G.; 58
Baboian, R.; 1594
Babusci, Louis D.; 600, 1766
Bachmann, K.J.; 320
Baer, David A.; 1748, 1861
Bagdanov, V.I.; 3267
Bagotskii, V.S.; 590, 3280
Bagotzku, V.S.; 3385
Bagshaw, N.E.; 244
Bairachnyi, B.I.; 3271
Baker, Bernard S.; 782, 782A, 782B, 1844
Ball, G.L.; 781
Ball, James V.; 203, 366, 628, 963, 1453, 1725, 1726
Ball, W.L.; 326
Banes, R.S.; 582
Bant, J.A.; 1878
Baranov, A.I.; 3323
Bard, Allen J.; 731B 1202C, 1397, 1426B, 3292
Barnartt, Sidney; 218, 296
Barnard, R.; 3378
Barnes, Stanley Charles; 1960
Barnett, Robert E.; 429, 588
Barney, D.L.; 1873
Barradas, R.G.; 1730
Barrard, R.; 3002
Barrett, Wayne T.; 1033
Barsukov, V.A.; 3253, 3254, 3260, 3261, 3277, 3278, 3321
Bartlett, J.H.; 743
Bateria, H.P.; 3265

Bates, M.W.; 1185
Bauchke, Friedrich G.K.; 1263
Bauer, H.H.; 3830
Bauer, Paul; 88, 169, 649, 653, 1294, 2068
Bauer, Richard; 2180
Bauman, H.F.; 352, 936, 938, 939, 941, 942, 952, 959, 986, 987, 988, 989, 990
1032, 1129, 2108, 2111, 2112, 2113, 3185
Baumstark, George; 79, 148, 149, 830
Beals, D.L.; 2034
Beauchamp, D.; 1799
Beauchamp, Richard L.; 1695, 1696, 1888, 2018, 2019, 2021
Beccu, K.D.; 3051, 3219, 3318
Beck, T.R.; 529, 642
Beck, W.R.; 1810
Behi, W.K.; 1425
Belofsky, H.; 264
Belove, Louis; 39, 44, 57, 62, 111, 514, (1608, 2074, 2158)
Belyaev, B.V.; 798, 799
Benak, James L.; 1887
Bene, J.; 1918, 3133, 3166
Bengtson, G.W.; 3011
Benjamin, F.; 3003
Bennion, Douglas N.; 1111, 1161, 1276, 1577, 1606, 1728, 1788, 1897, 1946
2039, 2052
Benoit, R.L.; 1261
Benrey, Ronald M.; 119
Benton, Mildred; 965
Berardelli, Maria Ludovica; 1485, 1561
Berchielli, Aldo S.; 425
Berezina, N.V.; 808
Berg, C.; 20, 21
Berg, Marcus; 1583
Berger, Carl; 208, 964, 1477, 2048, 2126
Bergstrom, Sven; 52
Bergum, Bernard C.; 2165, 2171
Berju, Klaus K.; 573
Berndt, D.; 1815
Besmann, T.; 2140
Betteridge, Walter; 3223
Betz, F.E.; 691, 1198, 1524
Bevan, H.L.; 3193
Bezaudun, J.; 3051
Biagetti, R.V.; 1767, 1769
Biddick, Royce, E.; 466
Bidler, J.L.; 3382
Biedermann, George; 779
Bierdumpefel, Hans; 599
Biess, J.J.; 1610
Bigbee, III, John; 1821
Billerbeck, W.J.; 368, 1065, 3005
Binder, H.; 1943
Binder, Pierre; 3227

Birchenough, Arthur G.; 1992
Bird, Judith; 1572
Bishop, Wayne Scott; 483
Black, I.A.; 462
Black, Richard G.; 669
Blackham, Angus U.; 692, 780, 824, 833, 874, 1102, 1201, 1255, 1198, 1380,
1411, 1471, 1521, 1585, 1734, 2076
Bleasdell, Bob D.; 1911
Blickwedel, T.W.; 1364, 1544
Bloch, O.; 3207
Blomgren, George E.; 1481, 1849
Blonstein, J.L.; 252
Blossom, Raymond W.; 1552, 2187
Blurton, Keith F.; 747, 768, 1815, 1930, 2125
Bockris, J. O'M; 2129
Bodamer, G.W.; 243, 662, 663, 737, 866, 888, 1137, 1293, 1363
Bode, Hans H.; 288, 316, 317, 321, 479, 1347, 1815, 2151, 3389
Boden, David P.; 1029, 1086, 1113, 1238, 1462, 1600, 1792, 1793
Bogar, F.D.; 962, 1075, 1450
Bogner, R.S.; 209, 210, 673, 788, 1250, 1468, 1718, 1799, 1806, 2016, 3146, 2134
Bogotzky, V.S.; 3149
Boldin, R.V.; 3143, 3272
Bomberger, D.C.; 17, 293
Bomkamp, D.H.; 2143
Bondarenko, O.I.; 131, 509
Bonk, James F.; 345
Bonnaterre, R.; 3049, 3377
Bonner, Francis T.; 160
Boose, Emery F.; 435
Borsanyi, Alexander S.; 999, 1217
Bosman, A.J.; 3328
Boult, E.H.; 3316
Bounds, Ronald W.; 1513, 1933
Bourgault, Pierre L.; 5, 6, 126, 154, 608, 1545
Bowerman, E.R.; 3203
Bowers, Frederick M.; 466, 1688, 1815
Boyd, William A.; 2030, 2106
Bradley, Charles J.; 480, 570
Bradshaw, Benjamin C.; 56, 197, 481
Bradspies, J.; 240, 241, 356
Brady, B.; 864
Braeuer, Klaus H.M.; 1027, 1085, 1121, 1478, 1522, 1670, 1685
Braun, Leon; 2127
Breiter, M.W.; 92, 287, 903, 1567, 1739, 3335
Breivogel, F.W.; 1161, 1389
Brennan, Joseph B.; 146
Brenner, Abner; 548, 1862
Brettner, D.M.; 352
Breuning, Edmund; 168
Briggs, Donald C.; 128, 1512
Briggs, G.W.D.; 1273, 275

Briglio, A.Jr.; 3006, 3007, 3008
Brill, Jack N.; 1636
Bring, B.; 3009, 3373
Bro, P.; 281, 1444, 1590, 1697, 1759, 1895
Broadbank, R.W.C.; 1372, 1373, 1939
Broadhead, John; 1908
Brodd, Ralph J.; 466
Broglia, Edward P.; 2064, 2120
Bronstert, Franz; 159
Brooke, Jr., Charles W.; 670
Brooks, Edward; 2017
Brooman, Eric W.; 1100, 1249, 1340, 1341, 1368, 1637, 2085, 2132, 2133, 3010, 3011
Brown, Jr., A.D.; 1445
Brown, Harry; 2063
Brown, Jack T.; 1937
Brown, R.C.; 408
Bruckenstein, Stanley; 1570
Bruder, E.; 3298
Bruess, E.C.; 206, 322, 394, 401, 488, 507, 539, 620, 639, 736, 784, 806, 828, 890, 1069, 1149, 1150, 1433, 1434, 1435, 1727, 1867, 1868
Bruins, Paul F.; 48, 449, 650, 827
Brummer, S.B.; 240, 241, 356
Budgen, N.F.; 3349
Buhner, H.R.; 1086, 1238, 1792, 1793
Bukarinov, V.I.; 3308
Bulan, Edward P.; 1507
Bundy, W.S.; 1666
Burbank, Jeanne; 415, 521, 752, 1811, 2069
Burkett, Wilford B.; 1821
Burrows, Brian; 807, 1019, 1020, 1021, 1037, 1097, 1123, 1154, 1222, 1224, 1283, 1284, 1288, 1366, 1392, 1954
Busch, Daryle H.; 1885
Butherus, A.D.; 1770
Butler, Eliot A.; 384, 692, 715, 780, 824, 833, 874, 1102, 1201, 1255, 1298, 1380, 1421, 1471, 1521, 1585, 1734, 2076
Butler, James N.; 1009, 1038, 1030, 1046, 1124, 1128, 1157, 1383, 1463, 1501, 1543, 1569, 1778, 1907, 2049
Byers, Robert G.; 230
Byrne, Joseph J.; 995, 996, 997, 1072, 1217, 1662, 1847
Byzina, L.A.; 290

C

Caffoni, G.A.; 95
Cahan, Boris D.; 68
Cahoon, N. Corey; 2060
Caillley, Jean Pierre; 2105
Caiola, Amedee; 1628, 1802, 2166, 2188
Cairns, E.J.; 1691
Callahan, J.W.; 542
Campanella, Luigi; 2037, 2053

Cannone, Anthony G.; 1767, 1860
Canter, Arthur; 1426H
Cardwell, G.I.; 3057, 3058, 3059
Carlson, R.L.; 732A
Carmichael, Robert; 836
Carpenter, D.O.; 731A, 1202B, 1426A
Carr, Charles; 69
Carr, Earl S.; 1624, 1749, 1799, 1846, 1978, 2004, 2063, 3074, 3116, 3154
Carr, Frank A.; 1884
Carson, Jr., W.N.; 90, 202, 277, 306, 440, 496, 510, 655, 674, 698, 730, 844,
879, (1176, 1197, 1260, 1282,) (1557, 1629, 1812, 1815, 1817, 1823)
Case, Bl; 3035
Casey, Edmund J.; 5, 6, 16, 40, 114, 154, 315, 327, 340, 346, 608, 1356, 1412
1705, 1815, 3238
Cassidy, James E.; 26
Cassidy, R.M.; 3331
Cassota, M.L.; 95
Catherino, H.A.; 1557
Catotti, A.J.; 130, 310, 706, 1686, 1873, 3132
Cattabrigs, Robert A.; 1322
Caulder, Stanley Milton; 449, 650, 2093
Cebula, Leonard A.; 1750
Cessna, J.C.; 1976
Cezner, V.; 1563
Chand, Ramesh; 1540
Chapman, C.L.; 1350
Chapman, K.M.; 319
Charkey, Allen; 275, 1880, 2066, 2187
Charles, R.G.; 437, 522, 690, 1398
Charlip, Steven; 274, 489, 559, 729, 771, 802, 1042, 1441, 1525, 1609, 1837, 2094
Chassoux, Rene; 1996
Chebakov, V.D.; 2147
Chen, Joe; 1906, 2005
Cherdak, Arnold S.; 34, 477, 486
Cherepkova, I.A.; 3303, 3309
Chernyshevskii, N.G.; 3386
Chikisheva, A.P.; 3256
Chilton, Jr., J.E.; 937, 938, 940, 942, 943, 951, 952, 959, 986, 988, 989, 990, 1117, 1119,
1272, 2109, 2110, 2111, 2113
Cimino, A.; 3295
Chireau, Roland F.; 207, 213, 423, 732, 790, 886, 1474, 1721, 1722, 1723, 3180
Chobanov, Tsvetko; 2123
Choudhuri, Binoy K.; 2169
Chreitzberg, Augustus, M.; 466, 495, 716, 842, 1363, 1422, 1459, 1473, 1587,
1588, 1815, 1635, 1975, 2008
Christian, Karlheinz; 215, 528
Christopher, H.A.; 1260, 1469
Christy, Donald, E.; 1436, 1438, 1496, 1497, 1498, 1650, 1655, 1681, 1758, 1842,
1951, 1952, 1967, 2071, 2095, 2096, 2137, 2138, 2139, 3012, 3013, 3014,
3109, 3110, 3111
Chua, D.; 3016, 3101, 3371
Chukhlantsev, V.G.; 834

Cioni, J.L.; 3017
Clark, C.T.; 1618
Clark, Robert F.; 658
Clark, Walter W.; 47, 189, 190, 362
Clarke, T.G.; 1411
Clifford, John E.; 551
Clune, Richard R.; 227
Coates, A.; 900
Cocca, Frank J.; 308, 337, 414
Coggi, J.V.; 1647
Cogley, D.; 281
Cogley, David R.; 1038, 1039, 1383, 1463, 1543, 1569, 1907, 2049
Cohan, H.; 470
Cohen, George L.; 1177
Cohen, M.; 3194
Cohen, H.I.; 38, 84, 332
Cohn, Ernst M.; 420, 466, 1448, 1528, 1662, 3025
Cole, D.; 770
Coleman, Joseph J.; 847, 898
Coleman, J.R.; 1185
Coler, Myron A.; 115, 116
Collins, D.H.; 12, 243, 252, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911
Colston, Edward F.; 1172, 1520, 1800
Compagnia Generale Di Tettricità; 3144
Conner, W.J.; 937, 952, 2109, 2110
Conrad, Paul; 1814
Consiglio, J.A.; 277, 496, 636, 674, 730
Conti, F.; 1914
Conway, B.E.; 126, 1346
Cook, Alton L.; 1617
Cook, G.M.; 937, 942, 951, 952, 1117, 2111, 2113
Cook, Glenn M.; 1503, 1597
Cook, J.M.; 1272
Cooke, L.M.; 238, 738
Cooper, J.E.; 738, 2067
Corbett, R.; 1014, 1106
Corbett, Robert E.; 1527, 2033, 3018
Corbin, Ralph L.; 1894
Corren, Sidney A.; 115
Costa, Raymond L.; 2146
Cover, Paul W.; 1410, 1581
Covington, A.K.; 810
Cox, Irwin W.; 1931
Craig, Gale M.; 1005, 1018, 1082
Crawford, R.L.; 1259, 1299, 1432, 1454, 1630
Crennel, J.T.; 3391
Criss, Cecil M.; 1312
Croft, George T.; 3325, 3327
Cuddihy, Edward F.; 1720
Cuenot, Charles; 1962
Cupp, Earl B.; 302, 392, 407, 578, 1617
Cushing, F.S.; 495, 716

D

Dagnall, R.; 467
D'Agostino, Vincent F.; 466, 731D, 1426E, 1639, 1716, 1735, 1815, 1940, 3294
Dahlberg, E.P.; 3195
Dalard, F.; 1592
Daley, John L.S.; 108
Dalin, George A.; 305, 312, 389, 452, 459, 466, 515, 581, 583, 635, 738, 749
756, 897, 1406, 1429, 1564, 1712, 1815
Damjanovic, A.; 2086, 2129
Dangel, Phoenix N.; 1708, 1800
Daniel, Arthur F.; 3
Dasoyan, M.A.; 1920, 3250
Daspet, H.; 1662
Dassler, Adolf; 168, 1/0
Davis, Marion MacLean; 1342
Davis, Stanley M.; 1964
DDC; 3008
Dean, J.R.; 3331
De Bethune, Andre J.; 1315
Dechenaux, Victor Louis; 1239, 1386, 2035, 2185
De Gromobov, T.S.; 286
De Hann, Frank; 341
Dehmelt, Klaus; 63, 135, 288, 3389
De Luccia, J.J.; 2081
De Jonge, Cees; 1906, 2005
Delahay, Paul; 1501
Deng, E.; 739
Denison, C.A.; 1173
Dennestadt, W.; 1928, 3176, 3184
Denstedt, W.; 2151
De Roos, J. Barry; 554
De Rossi, Mario; 1502
Desbarres, J.; 1261
Deschamps, Robert M.; 1062
Devanathan, M.A.V.; -175
DeVault, J.C.; 1433, 1434, 1435, 1436, 1437, 1438
Devitt, J.L.; 3228
DeWane, Harold J.; 1148
DeWolf, P.M.; 3336
Dey, Arabinda N.; 1041, 1134, 1153, 1182, 1188, 1444, 1565, 1692, 1759, 1947,
2010, 2050, 2189
Dhabanandana, S.; 1372
Dickfeldt, Siegfried; 216, 221, 1932, 2116
Dickinson, C.D.; 1196
Dieberg, Rudolf; 216, 221
Dieckamp, H.M.; 1661
Diefendorf, R.J.; 3016
Diggle, J.W.; 2086
Dines, James M.; 429
Di Pasquale, Renato; 297, 425

Dirkse, Thedford P.; 231, 232, 236, 324, 325, 341, 342, 343, 344, 347, 348,
353, 357, 386, 410, 411, 412, 413, 460, 485, 503, 504, 505, 514,
518, 531, 536, 554, 555, 576, 580, 596, 684, 687, 738, 740, 794,
878, 1194, 1200, 1202A, 1348, 1426C, 1486, 1653, 1696, 1815, 1883,
2013, 2014, 2060
Dixon, G.D.; 869, 1055, 1170, 1398, 1715
Dixon, J.H.; 609
Doan, Donald J.; 1733, 1815, 1846, 1978, 2004, 3074, 3116
Doe, James Bruce; 1358
Doetsch, E.; 610
Doggrell, L.A.; 1398
Dohren, H.; 3389
Dolgushin, M.D.; 2087
Donnelly, Paul C.; 97, 569, 621D'Onofrio, Elmer; 616
Donovan, R.L.; 3234
Doran, Richard Joseph; 1395
Doren, Hans V.; 135
D'Orsay, Emmanuel; 1111, 1181, 1248, 1728
Drachev, G.G.; 2154
Drazdauskas, C.J.; 1554
Driscoll, John S.; 997, 998, 999, 1217, 1262, 1291
Drobyshevskii, V.N.; 290
Dubois, A.R.; 6, 327
Dubois, B.J.; 3077
Duddy, Joseph C.; 49, 50, 181, 239, 1963, 2121
Dufour, Charles; 1062
Duisman, J.A.; 1174
Dümbgen, G.; 3299
Dunaeva, T.I.; 1913, 2156, 2172, 2173, 2174
Duncan, E.C.; 3057, 3058, 3059
Dunlop, James O.; 1281, 1513, 1799, 1933, 2107, 3167, 3411, 3412
Dunn, Jr., E.J.; 1666
Dunnett, J.S.; 1207
Dunning, John S.; 1788, 1897, 2052
Duze, Sylvia; 2179
Dyer, C.K.; 1881
Dyson, W.H.; 745

E

Easterling, Robert G.; 1738
Economy, George; 594
Edelstein, Fred; 1815
Edison, Thomas A.; 851
Edmondson, K.; 3333
Edwards, R.N.; 29, 30
Eicke, Jr., W.G.; 549
Eisenberg, Morris; 352, 961, 1044, 1045, 1048, 1116, 1118, 1139, 1161, 1214,
1389, 1523, 1534, 1797, 1850
Elder, John P.; 447, 742, 1299, 2032, 3198, 3398
Elema, Renno Jacob; 2122

Elgas, D.H.; 1787
Elisan, R.R.; 3160
Elison, J.; 3233
Elliott, William E.; 923, 944, 945, 945, 947, 991, 992, 993, 994, 1030, 1088,
1091, 1120, 1130, 1268, 1752, 1754
Ellis, Grenville, B.; 53, 151, 223
Ellison, J.E.; 1602
El-Sobki, K.M.; 3369
Enke, C. G.; 1911
Enters, Robert F.; 191, 199, 272, 1673, 1789, 1790, 1819, 3125
Epstein, S.D.; 723, 801, 921, 1225
Erbaugh, L.E.; 781
Ereiskaya, G.P.; 1913, 2156, 2172, 2174
Ergun, Sabri; 918, 1162, 1306, 1667, 1784
Erickson, S.K.; 1272
Euler, Karl Joachim; 226, 316, 317, 1344, 1756, 2148
Evans, D.J.K.; 70
Evans, G.E.; 376, 811
Ewe, H.; 3015

F

Faber, P.; 3183
Fagan, F.G.; 1901
Falzone, R.L.; 3181
Fajer, Jack; 1319
Faletti, Duane, W.; 1357
Falk, Sven Uno; 51, 1479, 1740, 1815, 3293
Farley, V.P. Jr.; 3211, 3212
Farr, J.P.G.; 3362
Farrar, J.; 368, 953, 954, 955, 1036, 1079, 1080, 1081, 1098
Farris, C.D.; 1336, 1399, 1838
Fateeva, V.N.; 3242
Faust, Charles L.; 551, 708, 777, 821, 915, 1220, 1340, 1089, 1377
Feder, David O.; 600, 1766, 1767
Feduska, William; 1937
Feldman, D.; 102, 293, 3139
Feller, H.G.; 3033
Feng, Helen; 1322
Fesenko, L.N.; 2152, 3259
Fisher, Aaron; 2106
Fisher, J.I.; 3382
Fishman, V.I.; 131
Fitchman, Arthur; 616, 830
Fleischer, Arthur; 18, 43, 54, 61, 77, 78, 180, 361, 577, 582, 585, 587, 703,
738, 1147, 1281, 1344, 1365, 1409, 1455, 1456, 1457, 1458, 1547,
1548, 1549, 1550, 1815
Fleischmann, C.W.; 632, 679
Fleischmann, M.; 3334
Fleming, Donald K.; 2082
Flerov, V.N.; 695, 724, 725
Fogle, R.F.; 733, 734, 787, 822, 1757
Foley, R.T.; 530, 538, 688, 867, 956, 962, 1017, 1071, 1074, 1075, 1107, 1108,
1136, 1254, 1265, 1285, 1301, 1428, 1450, 1494, 2143
Folks, Leroy; 378

Fono, P.; 3019, 3020
Font, Silvio; 2107, 3021, 3022, 3023, 3042
Ford, Floyd E.; 204, 383, 520, 1151, 1281, 1470, 1799, 1861, 2041, 2106, 2107,
3024, 3025, 3168, 3408, 3410
Fördyce, J. Stewart; 1310
Foster, James N.; 967, 983, 984, 985, 1024, 1295
Fowler, Peter; 466
Francis, Howard T.; 72, 3216, 3409
Frank, Harvey A.; 783, 823, 889, 1252, 1472, 2027, 3026, 3192
Frayer, F.; 1445
Freund, John M.; 2160
Fresnel, J.M.; 3051
Friedman, Harold L. 1489
Freidman, Richard; 1865
Frink, Jr., Arthur M.; 29, 67
Frysinger, Galen R.; 2089
Fuglarz, M.; 3177
Fujinaga, Taitiro; 2051
Fujisawa, Y.; 3214
Fujita, K.; 3101
Fukuda, Masataro; 165, 214, 426, 565, 666, 896, 1393, 1701, 1763, 1858, 2036
Fydelor, P.J.; 1878

G

Gabano, Jean-Paul; 1183, 1760, 1774, 1775, 1877, 2035
Gagnon, E.G.; 1576, 1674, 1916, 2062, 3138
Gaines, Lewis; 1284, 1366
Gaiser, L.; 1560
Gaivoronskaya, N.P.; 2156, 2174
Gale, R.J.; 911
Gallagher, John P.; 2083
Galushko, V.P.; 3262
Gamaskin, E.I.; 916, 3129, 3130
Gandel, Martin G.; 196, 758, 1815, 2106, 3156
Gardner, L.L.; 3238
Garnsey, R.; 1163
Garratt, P.G.; 333, 358, 369, 800
Garrett, Alfred B.; 345
Garten, Wilhelm; 135
Gary, Jr., Wright W.; 141
Gasser, R.P.H.; 1207
Gaston, Steve; 1281, 1799, 1800, 2106, 3029
Gatrell, Roger; 1603
Gay, E.C. 1691
Gayer, K.H.; 3326
Gedansky, L.M.; 1266, 1338
Geis, Jack W.; 2117
Gellman, Gary; 396
George, E.; 381
Gerald, H.; 3090
Gerbier, G.; 1239, 1386, 1877, 2035, 2185

Gershman, M.B.; 2155
Chosh, S.; 59
Giauque, W.F.; 1174
Gidaspow, Dimitri; 782, 782A, 782B, 782C, 864, 1056, 1318, 1360, 1844, 3200
Giles, R.D.; 1684
Gillman, Leland M.; 2167
Gilman, Sol; 2015
Gillibrand, M.I.; 120, 244
Gilroy, D.; 1781
Gindells, Ya.E.; 3289
Giner, Jose, 1283, 1359, 1442, 1572, 1578, 1642, 1643, 1671, 1910
Giovanelli, Robert A.; 464, 465
Gladstone, B.; 1622, 1623
Glassner, Alvin; 1320
Glass, M.C.; 3018
Glatz, Alfred C.; 2015
Glemser, Von Oskar; 3341
Glicksman, R.; 7
Goebel, F.; 1945
Golben, Michael; 1110
Golub, Yu. S.; 3241
Golubtsov, A.A.; 3267
Gomis, Jean P.; 2184
Gondusky, J.M.; 1401, 1432, 1454, 1632
Goodings, J. M.; 3356
Goodkin, Jerome; 251, 702, 756, 825, 865, 1099, 1139, 1289, 1406, 1508
Goodman, Roger M.; 227
Gordon, Dale; 3131, 3132
Gordon, Saul; 1741
Gordy, D.J.; 2088, 2118, 3030, 3032, 3061, 3062, 3063, 3064, 3342
Gere, Jon S.; 1053
Gorodetskii, Yu. S.; 609
Gorokhova, L.V.; 2154
Goach, C.O.; 378
Gosser, Robert B.; 218
Gottesman, Uscha; 138, 406
Gottlieb, Melvin H.; 95, 442, 648, 3225
Gower, Judith L.; 1088
Grachev, D.K.; 2009
Grasser, R.; 3170
Grahame, David C.; 1550, 3200
Gray, W.; 30
Green, C.R.; 498
Green, K.B.; 892
Green, Raymond S.; 3239
Greene, F.W. 1173
Greene, P.D.; 1165
Greenler, P.H.; 335
Gregor, Harry P.; 1316, 1815
Grenall, A.; 371
Grens II, E.A.; 3348
Grieger, Philip F.; 334, 359, 375, 697
Griffiths, Leonard B.; 2186
Grilikhes, N.E.; 916

Grimes, C.G.; 65
Grolnic, N.M.; 1836
Gross, P.; 1165, 1165
Gross, Sidney; 644, 883, 1439, 1815, 1956, 2130, 3034
Grube, G.; 610
Gruber, Bernard A.; 996, 1072
Grun, Charles; 69
Grunwald, Ernest; 1569, 1907, 2049
Grushkina, S.A. 3251
Gubner, Elmer; 1688, 1815
Gulyamov, Yu. M.; 2087
Gunther, R.; 3180
Gupta, N.K.; 492
Gutjahr, Manfred A.; 3318
Guy, Henry; 1628, 1802, 2166, 2188

H

Haas, R.J.; 1601, 1648
Hadley, R.L.; 1197
Hagenbuch, W.G.; 1092
Hagyard, T.; 319
Hahn, Henry; 1297
Haines, R.L.; 630, 1709, 1729
Hale, J.M.; 247
Hall, Clifford James; 2163
Halleck, G.; 3050, 3113, 3114, 3140
Halpert, Gerald; 466, 541, 826, 870, 1270, 1281, 1270, 1384, 1385, 1430, 1700,
1773, 1799, 2046, 2107, 3004, 3036, 3174, 3361, 3372, 3408
Hamer, Walter J.; 4, 1148, 2060
Hamlen, Robert P.; 872, 1762
Hammar, Richard H.; 1870
Hammel, R.L.; 371, 511
Hampartzumian, K.L.; 1882
Hampel, Clifford A.; 3345
Hampson N.A.; 1411, 1974, 2013, 2054, 3362
Hancock, H.A.; 70
Hanson, Douglas C.; 967, 1295, 1562
Hanson, K.L.; 1553
Hardman, C.C.; 3218
Hardly, Charles Rupert; 137
Harivel, Jean-Pierre; 86, 175, 245, 294, 901, 1351, 1680, 3357
Harkness, J.D.; 1555, 1736, 1842, 2059, 3012, 3014, 3037, 3038, 3039, 3040,
3041, 3128, 3134
Harlow, G.A.; 1742
Harlowe, Jr., W.W.; 764, 1361, 1400, 1414, 1488, 1640
Harootyan, Leo S.; 2146
Harris, E.L.; 738
Harris, W.S.; 1189, 1277
Harrison, A.I.; 1876
Harrison, J.A.; 1684
Harsh, William C.; 1573, 1733, 1846

Hart, Anthony Christopher; 1761
Hartman, George S.; 842
Hartner, A.J.; 3395
Harvey, Jay A.; 1085, 1126
Hauel, Anna P.; 19
Haugen, W.E.; 3099, 3100
Haul, R.; 3296, 3299
Hausler, E.; 904, 1353
Hawkins, B.R.; 651, 1749
Hayase, Y.; 3214
Hayman, C.; 1144, 1165
Haynes, Joseph C.; 2046
Headridge, J.B.; 1604
Heaner, S.L.; 790A, 886A
Hector, L.G.; 22
Hein, Edward R.; 2170
Heise, George W.; 2060
Held, Walter, 298
Helgen, L.E.; 1017, 1107
Heller, A.F.; 3135
Helton, Daniel J.; 1005
Hender, B.S.; 260
Henderson, Ian Hs.; 40, 87, 630, 815, 1345
Henley, Ernest J.; 713
Hennigan, Thomas J.; 420, 569, 631, 634, 1281, 1717, 1800, 1815, 1938, 1968,
2106, 3025, 3043, 3044, 3045, 3046
Henni, L.; 3303
Henry, J.F.; 2025
Hepler, L.G.; 1338
Herbert, Danuts; 1375, 1396
Herbert, W.S.; 64, 65
Heredy, L.A.; 1690, 2092
Herman, Bernard H.; 283, 3211, 3212
Hermann, John; 616, 793
Herold, Charles Victor; 667, 1982, 1983
Herold, Rudolphe A.; 162
Herold, Victor; 142, 469, 863
Herrick, Ivan W.; 1357
Herrmann, Cal C.; 1047, 1156
Herrmann, J.; 1574, 3048
Hersch, Paul A.; 755
Hersch, P.; 3344
Hess, Heinrich J.; 1698, 1853, 2090, 3186
Hetherington, W.M.; 1337, 1468
Hettmer, J.N.; 394
Heusler, K.E.; 1560
Hietala, J.H.; 1173
Hietanen, Sirkka; 778
Hietbrink, E.H.; 1004, 1018, 1923
Hill, K.R.; 1001, 1002, 1003, 1122, 1188, 1244, 1269
Himy, Albert; 450, 490, 597, 735, 875, 876, 1221, 1390, 1410, 1452, 1751, 1801
Hirai, Taketsugu; 165, 426, 565
Hirano, A.; 3224
Hirsch, H.H.; 879, 1176

Hear, T.P.; 1881
Hobbs, B.S.; 3151
Hodge, B.J.R.; 1875, 2153, 3049, 3377
Hofmann, M.; 1189
Hofman, J.C.; 1901
Hoffman, Arthur Kentaro; 1008, 1533, 2002
Holechek, Joseph J.; 464, 465, 568, 819
Holeman, J.M.; 1141, 1226, 1381
Holland, Jarry W.; 2060
Holleck, Gerhard; 1383, 1442, 1543, 1578, 1642, 1643, 1671, 1910, 2055, 2077, 2119, 3050, 3113, 3114, 3140
Holmes, Robert W.; 1049, 1160, 1180
Holsinger, R.W.; 937, 940, 1119, 2109, 2110
Holtquist, A.E.; 959, 988, 989
Holub, Fred F.; 1493, 1711
Hon, John F.; 967, 985, 1023, 1024, 1295, 1795
Honey, Eric Maurice O'Conner; 137
Hopper, M.A.; 3147
Hopkins, J.; 2119, 3050, 3114
Hopton, R.L.; 1864
Horn, Lutz; 216, 221, 222, 292, 776, 2116, 3208
Horne, R.A.; 462, 579
Horning, R.J.; 1810
Horowitz, Carl; 1614
Hosol, S.; 3224
Hosono, Tomizo; 13, 14, 73, 74, 75, 76
Hostomsky, J.; 1563
Howard, John; 1942
Howard, Paul L.; 66, 211, 338, 1193, 1815
Howard, Robert; 2107
Howatt, Glenn N.; 283
Howden, W.E.; 100, 908
Hoyt, Howard E.; 439, 660, 711, 712, 769, 1714
Hoytink, G.J.; 1501
Hsa, Shih-Liang; 945, 946, 947, 1120, 1130
Hsueh, Limin; 1946, 2052
Hubbauer, P.; 1702, 2128, 3071
Hubbell, Harry Cross; 103
Huber, K.; 3354
Huebner, D.F.; 390
Huff, James R.; 928, 944, 991, 992, 993, 994, 1030, 1088, 1193, 1754
Huffman, H.L.; 1582
Hughel, Thomas, J.; 1670
Hull, Michael N.; 1602, 1655, 1994
Humphrey, J.R.; 1304
Hurley, Georges F.; 1322
Huster, G.; 1345
Hussey, R.J.; 3197
Hutson, A. R.; 3360

Iliev, V.; 2072
Illstrup, Marshall E.; 482
Imamura, M.S.; 3234
Inada, Kuniaki; 3312
Ingling, William G.; 47, 189, 190, 362, 1807
Iseki, S.; 3150
Ishido, Osamu; 3312
Ishikawa, N.; 1360, 1844
Ishikawa, T.; 3104
Ivanenko, L.A.; 1920
Ivanov, B.P.; 3287
Iwaki, Tsutomu; 165, 214, 426, 565, 666
Izutsu, Kosuke; 2051

J

Jackovitz, John F.; 1815, 3139
Jackson, George W.; 1481, 1849
Jackson, T.P.; 1520
Jacob, Warner; 1281
Jacquier, Michel C.J.; 856
Jacquier, Pierre A.C.; 143, 144, 858
Jagid, Bruce; 494, 659
Jakobi, W.W.; 279
James, Herbert I.; 2006, 2182
James, W.J.; 535, 744
Jammot, J.; 2035
Jamrozy, Judith L.; 928, 991, 992, 993, 994
Januszkiewicz, Stanley; 60, 1458, 1548, 1549, 1550
Jarrousseau, J.C.; 1879, 2184
Jasinski, Raymond; 491, 506, 700, 871, 1019, 1020, 1021, 1028, 1037, 1087,
1097, 1123, 1125, 1132, 1135, 1154, 1222, 1284, 1288, 1366, 1392,
1556, 1659, 1973, 2070,
Jayaraman, T.R.; 3188
Jeannin, Robert A.A.; 854
Jee, B.C.; 782, 783B
Jerabek, Elihu C.; 1762
Jhon, Mu Shik; 2178
Joel, H.A.; 1164
Johannsen, Klaus; 1863
John, Ferdinand J.; 98
Johnson, D.; 1878
Johnson, Dorothea M.; 1845
Johnson, J.W.; 739
Johnson, Deith, 445, 2044
Johnson, Richard E.; 1236, 1669
Johnston, W.V.; 1780, 1869
Jones, C.; 3036
Jones, Elizabeth; 1273, 1274
Jones, Richard A.; 230, 1894
Jonville, P.; 3051

Jordan, A.W.; 1834
Jordan, John P.; 536
Jordan, Jr., Wade H.; 1885
Josephs, R.H.; 3173
Joshi, A.V.; 1566
Just, D.; 3296, 3299
Jost, Ernest M.; 129, 447, 456, 633, 845, 1889, 1893, 2100, 3398
Jouanneau, A.; 3077
Joyner, P.A.; 811
Julseth, D.H.; 3234
Jumel, Y.; 1183
Jungner, Ernst Waldemar; 128
Juvinall, G.L.; 788, 3052

K

Kafesjian, Ralph; 1072
Kann, Andre Leon; 1982
Kalman, Otto F.; 967, 985, 1024
Kaminskaya, E.A.; 2164, 3252
Kanada, Yoshimi; 3304
Kandler, Ludwig; 1427, 3247
Kanetsuki, K.; 3202
Kanezuki, K.; 896
Kang, Hong Yol; 1697, 1895, 1901, 1915
Kantner, Edward; 8, 84, 332, 336, 355, 360, 370, 385, 418, 430, 448, 497, 1465
1621, 1622, 1623, 1816, 1918, 1948, 1949, 1995, 3053, 3133
Karev, B.D.; 2147
Karpova, F.F.; 3272
Kas'yan, V.A.; 3309
Katan T.; 3185
Kato, Mitsuya; 629, 817, 1993
Kato, Sadao; 1772
Katsoulis, C.G.; 538, 2025
Katz, R.; 1441
Kawashima, Kenzo; 3311
Kazakevich, G.Z.; 590
Keating, Kenneth Bernard; 1830
Keiichi, S.; 3102
Keim, F.J.; 380, 1919
Kelchner, R.E.; 374, 795
Keller, Rudolf; 368, 953, 954, 955, 967, 983, 984, 985, 1023, 1024, 1036, 1079,
1080, 1081, 1098, 1043, 1295, 1562, 1782, 1795
Kelley, John J.; 738, 769A, 789, 1052, 1066, 1218, 1303, 1431, 1658, 1731
Kelly, Francis J.; 1192, 1511
Kelsey, Robert H.; 1901
Kelson, P.; 3054, 3169
Kemp, F.S.; 499, 529
Kent, C.E.; 887, 1264
Kent, J.R.; 805, 1482, 1747
Kenyon, L.W.; 487

Keralla, John A.; 233, 237, 314, 331, 367, 408, 502, 731, 750, 968, 1202, 1250,
Kerper, I.L.; 3160 1426, 1815
Kerr, R.L.; 1815, 3055, 3056
Kesting, Robert E.; 3236
Ketchum, M.D.; 1141, 1226, 1381
Kettler, Jack R.; 3255
Keusch, Preston; 1639, 1735
Khodarev, O.N.; 2175, 2176
Khomskaya, E.A.; 3246, 3281, 3386
Khomutov, N.E.; 1382
Khrushcheva, E.I.; 3385
Kikushkina, G.V.; 3280
Kim, Jongmin; 1464
Kin, Chai Won, 2178
King, L.A.; 1445
King, Randall N.; 1823
King, Robert B.; 1310
King, T.E.; 40, 605, 630, 898, 1709, 1729
King, Jr.; T.L.; 382
King, W.J.; 3190, 3189
Kinsey, R.H.; 196, 3232
Kirkland, E.V.; 781, 831, 969, 1203, 1713
Kirkland, Susan; 1123, 1132, 1154, 1224
Kirkman, D.W.T.; 105, 910
Kirsch, W.W.; 3142, 3240
Kissin, Steve; 1281
Klein, M.; 1251, 2145
Klopp, D.W.; 1092
Klopp, E.M.; 880, 881
Kloss, A.I.; 3115, 3245, 3323
Klunder, Kurt W.; 1072
Knapp, Howard R.; 1016, 1133
Knauth, Walter, T.; 524
Knodler, R.; 3153
Kober, Frederick P.; 254, 552, 675, 741, 882, 902, 1507, 1880
Koehling, A.; 1943
Koesters, Ronald L.; 403, 1807
Koffygerg, F.R.; 3340
Kofstad,; 3350
Kohl, K.C.; 3065
Kolba, V.M.; 1691
Kolosov, A.S.; 3246, 3281, 3386
Koniski, Jiro; 849
Konopinski, Wladyslaw; 2162
Koontz, D.E.; 1766
Kopper, Edward C.; 35, 577, 585, 587, 1142, 1455
Kordes, Karl; 295, 2031
Koren, Heiman W.; 79, 148, 149, 150
Korman, Samuel; 1551, 1890
Kornfeil, F.; 55
Korolenko, V.A.; 1913
Kortum, G.; 3376
Korzhevina, V.V.; 3310
Kosholkin, V.N.; 3244, 3257, 3258
Koslover, Monty; 1531

Kosuga, Jiro; 1745
Kouba, Anna; 1166
Kozawa, Akiya; 2023
Kozhakova, A.A.; 695
Kozhevnikova, N.M.; 3303
Kozio!, Suzanna; 1548, 1549
Kozlova, R.L.; 3251
Kozlovskii, A.M.; 1058
Kraemer, Guenter; 3319
Krapivnyl, N.G.; 3260, 3261, 3277, 3278
Krause, Stanley J.; 1929
Krebs, Thomas R.; 225
Krebs, W.; 257, 261, 262
Krienke, W.; 3247
Kreitman, M.M.; 1990, 2097
Krischevskaya, A.M.; 3249
Krishman, C.V.; 1489
Krishtalik, L.I.; 1501
Krock, Richard H.; 2186
Kroger, H.H.; 96, 303, 438, 1451, 1686, 2026, 3132, 3136, 3155
Kronenberg, M.L.; 476, 880, 881, 3196
Krugman, Leonard M.; 9
Krushcheva, E.I.; 3149
Ksenzhek, O.S.; 3244, 3257, 3258, 3313
Kubokawa, Masao; 1063
Kudryavtsev, Yu. D.; 2152, 3259
Kuhn, A.T.; 3397
Kukoz, F. I.; 278, 838, 2147, 2152, 2176, 3242, 3267, 3284, 3315
Kuloz, L.A.; 589
Kul'min, L.L.; 3305
Kumazaki, Kunihiro; 629
Kuppinger, R.E.; 1044, 1048, 1159
Kuroki, Kazuhiko; 2151
Kurtzweil, T.Z.; 880
Kul'min, L.L.; 3305
Kuz'min, L.L.; 127, 280
Kuz'min, Yu. A.; 3307
Kwak, J.C.T.; 1413, 1675, 1676, 1805
Kyle, M.L.; 1691

L

Labat, J.; 901, 1879
Lablanc, E.A.; 470
Lackner, J.L.; 605, 1709, 1729
Ladan, Stephan G.; 87, 815, 1545.
LaFollette, H.H.; 1624
Lago, M.E.; 3148
Lai, S.C.; 739
Lake, Phyllis E.; 5, 6, 114, 154, 327, 340, 346, 608, 3356
Lakshmanan, S.; 1175
Lamb, E.F.; 3332

REV.LTR. B

Lambert, Robert L.; 601, 696
Lander, John J.; 233, 238, 314, 330, 331, 367, 408, 466, 502, 721, 738, 750, 968,
Landstedt, S.; 3009, 3373 1084, 1250, 1281, 1354, 1426D, 1704,
Lang, Maurice; 428, 1672 1815, 2024, 2067, 2157, 3171
Lange, Alfons, Erich; 168
Langelan, Harry C.; 124, 493, 1575, 1616
Langer, Alois; 296, 437, 453, 519, 522, 690, 1398, 1715, 1815
Langguth, Erich; 168
Langowski, J.J.; 1228, 1229, 1230, 1231, 1232, 1233
Lasne, Claude; 1446
Latner, Norman; 1317, 1374
Lauer, George; 289
Latham, R.J.; 2054
Laurent, J.F.; 86, 175, 294, 901, 1183, 1191, 1239, 1386, 1877, 1879, 3357
Lawrason, G.D.; 764
Lawson, Jon; 1854
Lax, D. 1815
Layte, H.L.; 3099
Lea, F. M.; 3391
Lebihan, S.; 3177
Lecouffe, Y.; 1349, 1875, 3226, 3227
Lee, J.A.; 3002, 3378
Lee, J.B.; 1411, 1974
Lee, John Choy; 1909
Lee, Joseph; 1426E, 1735, 1815, 1940, 3294
Lee, T.S.; 3407
Lehman, Mickael; 661
Lehmann, G.; 1877
Lehrfeld, Dan; 1815, 2107
Leibecki, Harold F.; 562, 1235
Leibovitz, J.; 1413, 1675, 1805, 1972, 2102, 2135, 2142
Leitz, Jr.; Frank B.; 2082
Lennon, T.; 1621, 1622, 1623, 1816, 1874, 1995
Lerner, Harry; 516
Lerner, Stephen; 201, 270, 379, 443, 475, 508, 619, 762, 811, 829, 877, 1257,
1504, 1514, 1525, 1837, 1874, 2094
Le Sergent, Cristian; 1446
Leuthard, John; 1281
Levin, Allan; 862
Levine, Abraham L.; 157
Levy, Daniel; 693
Levy, E.; 2003, 3057, 3058, 3059, 3160, 3169
Levy, Samuel C.; 1737, 1738
Levy-Pascal, Arie E.; 1477
Liebert, C.H.; 3060, 3127
Lifshin, E.; 647
Lilley, T.H.; 810
Lindauer, Richard; 1942
Linden, David; 3, 53, 1335, 1703, 1832, 2042
Lindenberger, W.S.; 1770
Lindstrom, K.G.H.; 1537
Linebrink, O.L.; 1101, 2132, 2133
Linford, Henry B.; 16
Linschitz, Henry; 1319

Lisks, John; 242, 304, 458, 1051
Litt, Michell; 1464, 1906, 2005
Littman, H.; 3145
Littman, F.E.; 1115
Liwski, Piotr P.M.; 204, 500, 512
Long, W.L.; 1337, 1468
Loser, W.; 1928, 3176
Louis, Arnold S.; 116
Loukowsky, Serge A.; 1828, 1829
Louzos, Demetios V.; 722, 2060, 3217
Lozier, G.S.; 7, 463
Luciani, C.; 248,
Ludwig, Frank A.; 1305
Luer, H.J.; 1766
Lufkin, D.A.; 1022, 1223, 1321
Lukashova, L.S.; 3288
Luke, I.F.; 189, 190, 362, 403
Luksha, E.; 2065, 2088, 2091, 2118, 3030, 3052, 3061, 3062, 3063, 3064, 3065
Lundholm, Joseph G.; 435
Lundquist, J.R.; 1405
Lunn, H.B.; 246
Lurie, Michael; 46, 99, 198, 373, 377, 397, 398, 584
Lustbader, Leonard; 693, 1138
Lutwack, Ralph; 671, 788, 1710, 1815
Lux, Walter Karl; 2123
L'vova, L.A.; 282, 2009
Lyail, Arthur E.; 84, 89, 274, 332, 385, 729, 771, 802, 922, 923, 924, 925,
926, 971, 972, 973, 974, 975, 976, 977, 1026, 1042, 1096, 1184, 1211,
1215, 1307, 1903, 1925
Lyczkowski, R.W.; 864, 1056, 1318, 1360, 1844
Lunch, C.G.; 401, 1433, 1434, 1435, 1436, 1437, 1438, 1898, 1899, 1900
Lyons, Gary; 1800
Lysaght, Michael J.; 1707

M

MacArthur, Donald M.; 759, 1559, 1589, 1871, 1981, 3366
MacDonald, J.C.; 995, 996
Mackiw, V.N.; 70
MacLean, J.T.; 499
MacKenzie, C.; 1799
Mahefkey, E.T.; 1990, 2079, 2097
Mahy, Tyler X.; 1000, 1015, 1073, 1127
Mains, Donald E.; 206, 420, 466, 1367, 1433, 1434, 1435, 1436, 1437, 1438,
1515, 1799, 2071, 2095, 2096
Maiden, C.E.; 3057, 3058, 3059, 3160
Makogon, Yu. O.; 2152, 3259
Makrides, A.C.; 240, 241, 356
Malachesky, Paul; 807, 1019, 1020, 1021, 1097, 1222, 1288, 1366
Malcolm, J.; 3034
Malmberg, Paul R.; 218
Mandel, Hyman J.; 53, 474

Mann, Charles K.; 1397
Mann, F. Watson; 105, 106
Mantell, Charles L.; 2061
Mao, G.W.; 1783
Marciniszn, Jr, J.P.; 956
Marek, Jiri; 3265
Marezio, M.; 3295
Margolin, D.G.; 2155
Maricle, Donald Leonard; 1924, 2002
Marincic, N.; 754, 1590, 2047
Markin, T.L.; 1495
Marr, J.W.; 674
Marsh, Richard A.; 682, 1579
Mas, Joseph A.; 603
Mathui, Prem Behari; 1012, 1689
Matsui, Masayoshi; 13, 14, 73, 74, 75, 76, 285, 1402, 3370
Matsui, R.G.; 3018
Mattheu, Henry W.; 464, 465, 819
Mauchly, J.W.; 801, 803, 921, 1225
Maurer, D.; 1799, 2019, 2020, 2021, 2106, 2107
Mauri, R.E.; 936, 986, 990
May, L.; 3182, 3363
Mayer, Stanley W. 1394, 3066, 3067, 3404
Mazac, C.J.; 368, 954, 1036, 1079, 1080, 1098
McBreen, James; 452, 749, 766, 804, 1302, 1406
McCallum, John; 551, 708, 777, 821, 915, 1089, 1100, 1101, 1152, 1220, 1249, 1281, 1340, 1341, 1365, 1368, 1376, 1377, 1410, 1519, 1586, 1627, 1845, 1945, 2007, 2043, 2078, 2084, 2085, 2131, 2132, 2133, 3010, 3011, 3068, 3069, 3070, 3089, 3090, 3205, 3231, 3237
McCard, Harold K.; 435
McCarthy, Robert J.; 544, 774
McClelland, Donald H.; 1208, 1209, 1477, 3228
McClure, Charles F.; 547
McCollum, William A.; 239, 1611, 1612, 1839
McDonald, Guy D.; 991, 992, 993, 994, 1268, 1505
McDonnell, D.B.; 1730
McDugall, B.; 3194
McElhill, Elizabeth A.; 436, 537, 661, 792, 868, 966, 1072, 1171
McEntee, Howard G.; 118
McEntire, R.H.; 3343
McGrath, R.J.; 3160
McGurn, Terence J.; 622
McHenry, Edwin J.; 466, 686, 908, 1281, 1613, 1702, 1800, 2018, 2106, 2107, 2128, 3071
McKague, F.L.J.R.; 630
McKee, James M.; 3;0
McKeirnan, William R.; 696
McKenzie, D.E.; 239, 1394, 1611, 1612
McKie, A.S.; 479, 610
McLaughlin, R.L.; 892
McLennan, Kenneth Charles; 117
McMurray, Charles L.; 1619
McNutt, James Edgar; 1830

McQuade, J.M.; 90, 872
McWilliams, G.E.; 1276, 1277
McWithey, Robert R.; 1054
Meade, Kenneth E.; 480, 570
Medina, V.E.; 3395
Meibuhr, Stuart G.; 1603, 1905, 1989, 2011
Melendres, Carlos; 1279
Melin, A.L.; 3209
Mellor, J.W.; 3351
Melson, William I.; 731C
Meltzer, Theodore H.; 225
Menard, Claude J.; 41, 284, 1985, 2091, 3030, 3052, 3072
Mendeleva, S.V.; 1912
Meredith, Robert E.; 1909, 3073
Merten, K.F.; 1553
Merten, Ulrich; 1167
Merz, W.C.; 960, 1000, 1014, 1015, 1073, 1092, 1106, 1483
Messalem, R.M.; 1972, 2102, 2135, 2142
Messemerger, Adele; 1878
Metcalf, III, Joseph E.; 1887
Methlie, II, George J.; 1851
Metzger, Jr., William H.; 323
Meyers, William F.; 1000, 1092, 1093, 1094, 1095
Michaels, R.; 971, 972, 973, 974, 975, 976, 977, 1441
Michel, W.E.; 3057, 2057, 3058, 3059
Migeon, J.; 245, 294, 3357
Mihail, R.S.H.; 3164
Mikhailenko, G.V.; 228, 278
Mikkelsen; 1800

Milazzo, G.; 3374

Miles, M.H.; 1189
Milewski, J.D.; 3338
Miley, D.G.; 1436, 1437, 1438, 2058
Milgate, Robert W.; 2083
Miller, Gerald H.; 393, 1627, 1815, 2007, 2084, 3069, 3070, 3089
Miller, Lee; 1978, 2004, 3074, 3075, 3076, 3116
Miller, W. Ralph; 577, 585, 587, 1455
Milner, Paul C.; 91, 772, 1768
Milnes, Hery Reginald; 136
Milov, V.A.; 2174
Milyutin, N.N.; 3143, 3272, 3308, 3309, 3321
Mindler, Albert; 1934
Minnick, Leonard J.; 1011
Miroshnichenko, A.S.; 3285
Mirza, Sia I.; 1946
Mishin, V. Ya.; 1064
Mitchell, G.D.; 867, 1108, 1136, 1254, 1285, 1301, 1428
Moacanin, Jovan; 1720
Moczygemba, G.A.; 1233
Moe, G.; 1815
Mohns, John Phillip; 1924
Monnot, John Ferreal; 861
Moore, R. J.; 1972, 2102, 2135, 2142
Moose, L.F.; 17, 293
Moran, P.H.; 879
Moran, P.J.; 1176

Morcom, K.W.; 1373, 1939
Morehouse, C.K.; 7
Morignat, B.; 245, 294, 901, 3357
Morley, J.R.; 1411, 1974
Morman, D.H.; 1742
Moroz, W.J.; 315, 327
Morozov, V.P.; 2087
Morrell, Donald Henry; 899, 1960
Morris, James F.; 269
Morrison, R.; 714
Moses, A.J.; 1468
Moses, E.; 678
Moshtev, R.V.; 1882
Moss, Vladimir; 1746
Mott, N.F.; 3329
Moulton, Joseph Donald; 139
Moyer, E.E.; 2029
Moyes, Karen R.; 1670
Mrgudich, John N.; 2060
Much, K.W.; 399
Mueller, Gustav A.; 219, 220, 1110
Muihead, James S.; 967, 1295
Mukunoki, Junki; 3311
Muju, B.L.1; 1372, 1373, 1939
Mukherjee, L.M.; 1462, 1600
Mullersman, Ferdinand H.; 1822, 3137
Mullinger, D.E.; 252, 586
Mundel, August B.; 36, 42
Murachkovskii, A.P.; 509
Murdock, James P.; 1615
Murphy, Frances G.; 1815
Murphy, Harold P.; 157
Murphy, John J.; 1328, 2098
Murphy, V.T.; 95
Murty, B.G.K.; 1318, 1360

N

Nad; 3078, 3119, 3172
Nagel, Bernard E.; 1603
Nagle, William; 1800
Nagorski, Witold; 156
Nagaura, S.; 3150
Nagy, G.D.; 114, 315, 1815
Nagy, Z.; 2129
Nakamura, Toshiaki; 3302
Nanda, Jatinder N.; 2169
Nanis, Leonard; 1464, 1510, 1906, 2005, 3079
NASA/GSFC; 3080, 3081, 3117, 3118
Nassler, Jindrich; 1230
Nathe, Raymond; 616, 1574

NATC ; 3082
Naugle, R.B.; 380, 1919
Naybour, R.D.; 786
Nefedov, K.P.; 625
Nekrasov, A.P.; 3271
Nelson, Alphonzo G.; 1946
Nelson, C.H.; 3083
Nelson, Robert F.; 1025
Nemodruck, A.A.; 127, 178
Nervik, Torbjorn; 2149, 3213
Ness, Peter; 1815, 1998, 3319
Neumann, Georg; 138, 140, 145, 161, 406
Newman, Gertrald H.; 1848
Newman, W.; 3084
Newton, Donald O.; 1195
Ng, D.Y.C.; 782, 864, 1056, 1313, 1844
Nichols, Lester D.; 269
Nicholdon, M.M.; 374, 795, 953, 954, 955, 1081, 1794
Niedrach, Leonard W.; 685
Nietzel, Oscar; 445
Niki, Hirokazu; 1859, 1988
Nikol'skii, V.A.; 3285, 3323
Nilson, R.R.; 277
Nole, Dominick A.; 1746
Nordblom, G.F.; 1422, 1473, 1587, 1588, 2182
Nordell, Carl A.; 1664
Norr, Marriner K.; 1177
Nosdvelova, V.D.; 3115
Novakovskii, A.M.; 2154, 3251, 3307
Novoselova, V.D.; 3245, 3307

O

Oakes, J.B. 388
Oberg, J.L.; 3234
Ockermann, J.B.; 253
O'Connell, John J.; 436, 537, 661, 792, 868, 966, 1171
Oestreicher, Ernst; 147
Ohakuma, Shiro; 3286
Ohashi, K.; 3150
Ohata, Isao; 3163, 3301
Ogawa, H.; 896, 3202
Ogromnov, P.V.; 3120
Ogunyankin, O.; 3036, 3372
Ohata, I.; 1856
Ohse, R.W. 3352
Okinaka, Yutaka; 427, 455, 557, 760, 908, 1407, 3355, 3365
Okuma, Shiro; 1656
Oliapuram, V. Antony; 1815, 1998
Oliver, R.L.; 3122
Olson, Carl A.; 792, 868, 966, 1171
Omel'Chenko, V.Ya.; 3305

O'Nan, T.C.; 3112
Orban, Gyula; 1426E, 1815
Ord, J.L.; 3147
Orenstein, S.; 1431, 1658
Orlando, Daniel; 848
O'Rourke, Joe; 2106, 2107, 3029
Orshich, J.; 971, 972, 973, 974, 975, 976, 977, 1211
Orsiuo, J.A.; 1666
Osawa, K.; 1856
Osipchuk, N. Yu.; 2173, 2174
Osteryoung, R.A.; 289
O'Sullivan, T.D.; 1769
Oswin, Harry G.; 632, 747, 1355, 1815, 1930, 2125, 3395
Otoo, Earl M.; 457, 723, 1169, 1694
Owen, John T.; 1999
Oxley, James E.; 466, 538, 632, 679, 1304

P

Packer, R.K.; 422
Padwo, Sau; 80
Paez, O.A.; 980, 981, 982, 1022, 1223, 1305, 1321
Paget, M.; 3207
Paiewonsky, B.; 1529, 1662
Palagyi, Tivadar Z.; 271, 351
Palandati, Jr., Charles F.; 569, 621, 970, 1440, 1717, 1815, 3025
Palmateer, Russell E.; 601
Palmquist, Nels B.; 432
Panich, R.U.; 3269
Pantier, Earl S.; 296
Panzer, R.E.; 1276, 1277
Papazov, G.; 2072
Papiev, N.A.; 1064
Park; 1800
Park, John; 2106
Park, Yung Woo; 2178
Parker, A.J.; 1542, 1852
Parker, Jr., Andrew J.; 1532
Parker, J.; 246
Parker-Jones, H.A.; 1076, 1077, 1078
Parry, John M.; 1322, 1408, 1416, 5139, 1620, 1776, 1799, 2055, 3381
Parsons, Roger; 1501
Partridge, G.; 1878
Pasciutti, Edward R.; 1420
Paster, Mark; 1906, 2005
Pasternak, Alan D.; 1045
Paczekiewicz, Marian; 2162
Pate, Marvin L.; 1987
Patro, S.; 1370
Patterson, R.; 1718, 1806, 2016
Patton, J.T.; 519

Paulkovich, John; 1470
Payne, Dewitt A.; 731B, 1202C, 1426B
Payne, Paul D.; 134
Payne, Richard; 1127, 1490, 1501
Payne, Wallace, F.; 1617
Pavlov, D.; 2072
Pavlovic, J.D.; 1116
Peach, Norman; 885
Pecci, Gianfranco; 1040, 1561
Peletier, D.P.; 1991
Pell, Melvyn B.; 1552
Pensabene S.F.; 130, 1686, 1873, 3085
Perks, R.P.; 132, 1635
Pervushin, Yu. N.; 2175, 2176, 3086, 3087
Peters, Freimut; 109, 110, 135, 152, 153, 155, 164, 176, 177, 909, 1932, 2116
Peters, K.; 1876
Peterson, David; 561
Petit, M.C.; 3077
Petraits, J.J.; 1018, 1082
Petrova, M.V.; 3250
Pettebone, E.R.; 604, 681
Pflugger, Helmuth L.; 439, 451, 660, 711, 712, 769
Philipp, Fritz; 216, 221, 222, 575, 776, 3208
Pichet, P.; 1261
Pickett, David; 2107, 3088, 3096, 3097, 3121, 3122, 3157, 3161, 3230, 3320, 3322
Piechon, J.; 3393
Pierce, C.; 3379

Pilla, Arthur A.; 1047, 1156, 2034
Pilla, Louis J.; 1703
Pinard, Emile J.L.; 2160, 3210
Pinches, P.B.; 38
Pinal, F.B.; 69
Piroux, Jean; 112
Pistoia, Gianfranco; 1040, 1485, 1502, 1886, 1914, 2037
Pivarnik, J.; 1607, 1608, 1753
Place, I.M.; 1076, 1077, 1078
Plachco, F.P.; 3148
Plantz, Albert R.; 1460, 1487, 1667, 1784, 1808
Plehn, P.E.; 873
Pchynok, Michael P.; 587
Pohlmann, Reimar; 1935
Poirier, A.R.; 1923
Polcaro, Anna Maria; 1485
Polcyn, D.S.; 1783
Poli, Guido; 291
Pollzck, W.; 3165, 3222
Pollock, J.T.A.; 2012
Pomerantz, Daniel I.; 1453, 1726
Pomroy, S.E.A.; 333, 358, 369, 800
Poole, D.F.C.; 252
Popat, Pranjivan V.; 454, 633, 748, 832, 919, 1140, 1259, 1401, 1432, 1454,
1476, 1480, 1630, 1665, 1969
Popova, M.G.; 3271
Portante, F.P.; 1326
Porter, D.F.; 3316

Porter, John T.; 1143, 1167
Pospelov, A.A.; 834
Post, Robert E.; 1815
Potter, Jr.; Andrew E.; 269
Potter, Nelson H.; 714, 1938
Pouli, Dirk; 1615
Power, Wilson H.; 1072
Powers, R.A.; 523, 694, 820, 920, 1057, 1067, 1296, 1297, 1343, 1541
Powers, R.W.; 746, 1591, 1663, 1699, 1904
Pozin, Yu.M.; 131, 509, 916, 1660, 1979, 3129, 3130, 3241, 3249, 3279, 3283, 3285
Prater, Keith B.; 731B
Prema, R.; 3264
Preusse, Karl E.; 466, 543, 1198, 1512, 1524
Pribadi, K.S.; 1266
Price, Elton; 1228
Prosen, Edward J.; 1694
Prue, J.E.; 1163
Pryaklin, O.R.; 3262
Przybula, Franciszeki; 1192, 1511
Purcell, Jr., T.H.; 1834
Puglis, V.J.; 3088, 3096, 3097, 3121, 3122, 3157, 3161, 3230, 3380
Putois, F.; 3049, 3377
Pyzybyla, F.; 3112

R

Rabinowicz, E.; 3343
Rabkin, E.; 27
Race, W.P.; 3338
Radford, Wade E.; 364
Radkey, R.J.; 492, 979, 980, 981
Radvilla, Peter; 748
Rafinski, A.H.; 3378
Raine, H.P.; 900
Rajagopalan, K.S.; 3334
Ralph, E.L.; 3380
Ramasubbalaksmi, R.; 3275
Rampel, Guy; 8, 273, 304, 332, 440, 458, 467, 510, 655, 844, 1258, 1333, 1379, 1629
1686, 3229, 3346, 3347
Ramsay, G.R.; 3112
Randhava, S.; 864, 1056
Rao, Mlarur L. Shaskara; 957, 958, 1002, 1003, 1043, 1049, 1122, 1160, 1180, 1182,
1188, 1244, 1269, 1484, 1901
Rao, P.V. Vasudeva; 2, 59, 318, 1059, 1682, 1683, 3264, 3275, 3276, 3364
Rappaport, Paul J.; 1, 29, 513
Rasevics, K.; 641
Rasor, Ned S.; 1662
Ratzer-Scheibe, H.J.; 3033
Ray, James D.; 984
Read, M.D.; 310, 706, 1554, 1732
Reams, J.D.; 3055
Recht, H.L.; 239, 374, 795, 1611, 1612
Reddy, A.K.N.; 3337

Schulman, Irwin M.; 33, 44, 75, 62, 473, 606, 613
Schult, R.W.; 32, 640
Schultz, Jr., Eugene B.; 582
Schultz, H.M.; 206, 394, 401, 539, 634, 701, 710
Schumacher, Erwin A.; 2060
Shurdak, Edward J.; 1964
Schwartz, Eugene P.; 2060
Schwartz, Harvey J.; 269, 705, 812, 1310, 3093, 3094
Schweitzer, Edward F.; 577, 585, 587, 1455
Scott, Jr.; Willard R.; 466, 787, 822, 1253, 1281, 1744, 1971, 2106, 3095,
3099, 3201, 3100
Scrosati, Bruno; 1040, 1502, 1561, 2037
Sears, Lawrence; 841
Scunde, Richard R.; 1992
Seefurth, Randall N.; 1005, 1082
Segovia, G.; 1076, 1078
Seiger, Harvey N.; 37, 38, 46, 84, 85, 89, 99, 104, 123, 185, 192, 198, 200,
201, 249, 270, 307, 332, 336, 360, 370, 373, 377, 379, 397, 398, 418,
443, 448, 475, 477, 478, 556, 584, 607, 622, 623, 626, 738, 762
771, 802, 877, 924, 925, 926, 971, 972, 973, 974, 975, 976, 977,
1006, 1026, 1042, 1184, 1211, 1215, 1257, 1281, 1307, 1504, 1525,
1799, 1824, 1874, 1925, 1966, 3088, 3096, 3097, 3122, 3159, 3166,
3215, 3394
Sekido, Satoshi; 1772
Selanger, Per; 3273, 3399, 3400, 3401, 3402
Selby, J.D.; 433
Selim, R.G.; 1001, 1002, 1003, 1114, 1131
Selis, Sidney M.; 31
Selitskii, I.A.; 1921
Selover, T.B.; 3175, 3178
Semones, Donald E.; 551, 1089, 1101, 1519, 1586, 2043, 2028
Senderak, K.L.; 3098
Senderoff, S.; 880, 881
Seo, E.T.; 1757
Seremak, J.; 546
Settembre, Erminio J.; 301, 417, 1626, 1645, 1785, 1941
Shaffer, Lloyd H.; 229
Shair, Robert C.; 8, 30, 34, 37, 38, 46, 84, 89, 99, 193, 198, 249, 304, 307,
332, 336, 355, 360, 370, 385, 418, 430, 458, 497, 543, 738, 811, 925
1026, 1042, 1184, 1198, 1215, 1524, 1966
Shapot, M.B.; 2155
Shaw, Manuel; 492, 731C, 978, 979, 980, 981, 982, 1022, 1031, 1208, 1209, 1223
1305, 1321, 1419, 1815
Sheinhart, I.; 1196, 3203
Shepherd, Clarence M.; 124, 328, 493, 1575, 1616, 3191
Sherfey, Joseph M.; 323, 420, 548, 550, 839, 870, 1384, 11863, 11896, 2046, 2115,
Shikon, A.E.; 3240
Shinoda, Yoshio; 3311
Shiralkar, B.; 3343
Shirogami, Tamotsu; 3312
Shoeld, Mark; 1957, 1958
Sholette, W.P.; 745
Shrier, L.L.; 286

Shteinberg, G.V.; 3280
Shtertser, N.I.; 3279
Shul'gina, G.A.; 3243, 3284, 3315
Shumilova, N.A.; 3149, 3385
Shure, Lloy I.; 812
Shuvalova, I.N.; 808
Siedlecka, Zofia, 291'
Sieh, R.H.W.; 1323
Sillen, Lars Gunnar; 778, 779
Silverman, H.P.; 1757
Simeral, Larry; 1584
Simmons, Gerald L.; 991, 992, 993, 994
Simmons, J.W.; 1092
Simon, A.C.; 1536, 1668, 1678; 2069
Singh, Parminder; 2169
Sivaramaiah, G.; 3276, 3364
Siwek, E.G.; 872, 887, 1141, 1226, 1381
Sizemore, Kenneth O.; 420, 434, 631, 634, 664, 1938
Skalozubov, M.F.; 228, 278, 589, 614, 1913, 2156, 2172, 2173, 2174, 2175, 2176,
3086, 3087
Skelly, L.A.; 3234,
Sliff, H.T.; 511
Sligh, Jr.; John L.; 1862
Smaldone, G.; 2140
Smedslund, Tor; 1953
Smit, J.; 1071
Smith, D.A.; 1787
Smith, D.W.; 899
Smith, Donald A.; 1540
Smith, F.H.; 1649
Smith, Robert L.; 2057
Smith, William W.; 704
Smyrl, William H.; 1112
Snow, G.E.; 731A, 1202B, 1426A
Snyder, Gilbert R.; 593
Snyder, Nathan W.; 33, 416
Snyder, R.N.; 1084
Sobel, Ilyitch J.; 774
Soboleva, L.I.; 3288
Soderholm, Lars G.; 1178
Sohn, J.C.; 1628, 1802, 2166, 2188
Solbrig, C.W.; 782, 864, 1056, 1844
Solomon, Frank; 250, 251, 525, 738, 1212, 1771
Solov'eva, K.M.; 1920
Soltis, Daniel G.; 1310
Sonner, R.; 3359
Sood, Raman; 1464
Sorensen, R.W.; 1378
Spacek, Edward; 1639, 1735
Sparks, Richard H.; 466, 643
Speiser, Rudolph; 594
Spellman, Patrick J.; 1965
Spera, V.P.; 1086, 1792, 1793

Sperrin, A.D.; 3002, 3054, 3297
Speyers, A.W.; 380, 1919
Spiegler, K.S.; 1413, 1675, 1676, 1805, 1972, 2102, 2135, 2142
Spindler, William C.; 1242, 1577, 2060
Spring, K.; 267
Srinivasan, T.S.; 1012
Stachurski, Z.O.; 305, 765, 897, 2080
Staffin, H. Kenneth; 713
Stafford, W.T.; 32, 640, 1610
Stager, David N.; 1971, 3056, 3099, 3100
Stamires, D.N.; 1076, 1078
Stanimirovitch, D.; 3393
Stanley, W.; 3123
Stark, Robert E.; 665, 2167
Staub, H. Thomas; 559, 623
Steeves, Ralph C.; 661
Steffens, Karl; 566
Steinhauer, Robert A.; 1281, 1290, 1388, 1601, 1648, 1800, 2001, 2106, 3135
Steinmetz, E.; 1332
Stemmle, James T.; 1800, 1980
Stern, G.; 2140
Steuernagel, Werner H.; 1580
Stevens, W.G.; 1787
Stewart, Warner L.; 269
Stoenehart, P.; 1325, 1326, 3107
Stoner, G.E.; 535
Stormont, R.; 2012
Straumanis, M.E.; 535, 744
Strauss, Howard J.; 107, 113, 158, 212
Strehlow, H.; 1229
Streigle, Paul E.; 464, 465
Strier, M.P.; 450, 466, 783, 823, 876, 889, 1115, 1252
Strohlein, Elmer M.; 573
Stromer, Peter R.; 268
Stroup, Eugene R.; 309, 420, 664, 683
Subcasky, W.J.; 1076, 1077, 1078
Sugita, Kuranoby; 818, 1656, 3286
Sukharev, A.G.; 3269
Sulkes, Martin J.; 69, 305, 312, 365, 389, 396, 459, 466, 515, 581, 583, 635
672, 2017, 2099, 3126
Sullivan, B.P.; 1565
Sullivan, Jack M.; 967, 983, 984, 985, 1023, 1024, 1562
Sullivan, Ralph; 1281
Sundberg, Erik G.; 1706, 1959
Sushentsova, S.N.; 3143
Svardal, Per S.; 2165
Swinehart, J.S.; 1074
Swinkels, Dom A.J.; 1005, 1018, 1034, 1082, 1083
Sylvia, J.; 1524
Synnott, John C.; 1463, 1543, 1778, 1907
Sysoeva, V.V.; 3303, 3309, 3310
Szego, George C.; 543, 796, 1328, 1529, 1530, 1661, 1662
Szymborski, J.; 1052, 1066, 1218

T

Taborek, E.j.; 1265
Tachkawa, Hiroyasu; 1202C, 1426B
Takehara, Zenichiro; 179, 591, 629, 817, 1598, 1843, 1993, 3353, 3367, 3368, 3370
Takahashi, K.; 3104
Takamura, Tsutomu; 1859, 1988, 3302
Tanis, Charles; 2022, 3171
Tarantino, Robert V.; 336, 355, 360, 370, 430, 497
Tarasov, E.A.; 3242
Taylor, A.D.; 208
Taylor, D.; 3066, 3123
Taylor, J. Edward; 543, 1328
Taylor, R.J.; 931
Tehiely, David; 814
Tench, D.M.; 3187, 3199
Ten'Kovtsev, V.V.; 3250
Terent'Cv, N.K.; 3283
Teplinskaya, T.K.; 290
Teresa, Michael J.; 1527
Thacker, R.; 2144
Thaller, Lawrence H.; 1310
Thierfelder, H.; 1281, 1646, 1833
Thirsk, H.R.; 1815, 3316, 3334, 3338
Thomas, Charles; 2106, 2107
Thomas, R.E.; 1777, 1841, 2000, 2132, 2133, 2136, 3090, 3134
Thomas, Ralph E.; 1152, 1249, 3237
Thomas, Jr.; Upton B.; 12, 102, 772
Thompkins, A.; 1251
Thompson, C.D.; 2143
Thompson, J.C.; 1232
Thomson, William Sidney; 862
Thornell, S.; 793, 830, 1607, 1608
Tichenor, Robert L.; 859
Tidwell, Troy H.; 1519, 1586
Tiedmann, William H.; 1897, 2039, 2052
Tieder, R.E.; 1783
Tiller, Smith E.D.; 870
Tisch, Elvira; 3319
Tischer, Manfred; 298
Titterington, William A.;
Titus, H.; 1071
Tobias, Charles W.; 1112, 1263, 2069, 2070, 3348
Tochner, Max; 685
Toczycki, W.; 782, 864, 1056, 1318, 1360, 1844
Tomita, Y.; 894
Tomkins, F.C.; 3332
Toni, Jorge E.A.; 993, 994, 1234, 1268, 1447, 1602, 1605, 1752, 1994, 2040
Topol, Leo E.; 1839
Toshio, I.; 3102
Towle, Warren L.; 928, 944, 945, 946, 947, 948, 949, 930, 991, 992, 993, 994,
1030, 1088, 1120, 1130

Reddy, Thomas Bradley; 1926
Reed, Allan H.; 1365, 1376, 1410, 1581, 1800, 1945, 2131
Reed, J.L.; 744
Reid, David S.; 1314
Reid, L.; 770
Reinhardt, Frederick W.; 1737
Remanick, Allan H.; 492, 7310, 978, 979, 980, 981, 982, 1022, 1223, 1815
Resnic, Burton; 45
Rhyne, Jr.; John; 624
Rhyne, John W.; 646
Rice, James M.; 618, 1068
Richards, R.N.; 441, 734
Richardson, David L.; 579
Richardson, S.C.; 1141, 1226, 1381
Richect, Hans; 3341
Riechel, R.M.; 1787
Riffe, Delmar R.; 773
Rightmire, Robert A.; 1887
Ritterman, Paul F.; 42, 182, 183, 184, 185, 192, 200, 201, 270, 307, 355, 443,
448, 475, 497, 606, 613, 3096, 3122, 3215
Rivolta, Bruna; 291
Robbins, Fred E.; 1815
Robens, E.; 3164
Roberts, G.N.; 1136, 1254
Roberts, Ralph; 2060
Robinson, C.; 381
Robinson, J.M.; 511
Rodionova, V.I.; 1820
Rodot, M.; 1662
Roe, R.B.; 2034
Roeger, Jr.; Earl A.; 189, 190, 362, 402, 1152, 1365, 2084, 3011, 3069, 3089
3090
Romanov, V.V.; 266, 564, 627, 3028
Romanova, I.L.; 1921
Ropp, Jr.; Chester A.; 1892
Root, John J.; 1755
Rosa, Albert C.; 2161, 2168
Rosen, Alvin H.; 1599
Rosen, Joel C.; 1672, 1791
Roth, H.; 1332
Rotinyan, A.L.; 3309
Rousar, I.; 1563
Rouse, Thomas O.; 1902
Rowe, C.R.; 1688
Rowlette, John J.; 757, 1337, 1546
Royon, Jean; 1166
Rozentavieg, S.A.; 290, 1912, 2164, 3252
Ruben, Samuel; 404, 405, 1625, 1917, 2056, 2060
Ruberto, M.; 793
Rubin, Edward J.; 454, 761, 832, 919, 1401, 1432, 1454, 1476, 1480, 1394,
1631, 3141
Ruetschi, Paul; 68, 254, 350, 721, 1815
Rufenacht, F.; 129

Ruffing, C.R.; 437, 522, 690, 1398 ,1715
Russell, Charles, R.; 31
Ruzzo, Jr.J.G.; 3206
Ryan, R.J.; 463
Ryans, D.E.; 3331
Ryder, W.E.; 1514
Sagoyan, L.N.;224, 602, 668, 2087, 3253, 3254, 3260, 3261, 3277, 3278, 3321
Saha, P.K.; 3274
Saiki, Naoshi, ; 3312
Salauze, Jean; 852, 860
Salisbury, R.G.; 1076, 1078
Salkind, Alvin J.; 48, 49, 50, 243, 449, 650, 738, 745, 1815, 3179, 3293
Salomon, Mark; 1415, 1461, 1492, 1571, 1679, 2038
Salyer, I.O.; 781, 831, 969, 1203, 1713
Samoilenko, V.M.; 1743
Samoilov, G.P.; 3149, 3385
Sanders, Newell, D.; 269
Sanderson, E.R.; 265
Sandler, P.I.; 3028, 3266
Sandstede, G.; 1943
Sangermano, L.; 3358
Santhanakrishman, S.; 1682, 1683
Sareen, S.; 782, 864, 1056, 1318, 1360, 1844
Sato, Yuichi;:1859, 1988
Sattar, M.A.; 1346
Saunders, R.C.; 1690, 2092
Savelchikov, L.P.; 3020
Scala, L.C.; 709, 791, 869, 1055, 1170, 1398, 1715
Scandariato, J.P.; 2141
Scanlon, B.; 1411
Scardaville, Paul A.; 238, 563, 841, 1854, 3091
Scarr, Robert F.; 1491
Schaer, Glenn R.; 821, 1945, 3092, 3204
Schaer, M.J.; 1577
Schaffhauser, S.F.; 498
Scharmann, A.; 3170
Schehl, Richard R.; 1460, 1487
Scheibe, Horst; 299
Scherbakova, Z.V.; 290
Schiffer, S.F.; 1815
Schilling, Carl O.; 850
Schlecht, Leo; 147
Schlotter, W.J.; 1553
Schmeckenbecher, Arnold; 611
Schmeiser, Kurt; 2124
Schmid, Rudolf; 3318
Schneider, P.A.; 906, 1352
Schneider, Victor J.; 1480, 1979
Scholz, Paul 226
Schreier, L.A.; 745
Schreyer, James M.; 1741
Shubert, Glenn W.; 230
Shubert, L.; 1017, 1074, 1107

Tracey, V.A.; 217, 1635, 3223
Trachtenberg, I.; 770
Trafton, Thomas R.; 464, 465
Trevethan, D.G.; 821
Trevorrow, L.E.; 1691
Trickett, E.A.; 3141
Trischler, Floyd D.; 484, 884, 1638
Troitus, Cunnar; 907
Tseung, A.C.C.; 3151, 3190, 3193, 3189
Txuchida, T.; 3214
Tsupak, T.E.; 3288
Tuomi, Donald; 125, 3325
Turchan, Michael; 1359, 1572, 2119, 3050, 3114, 3140
Turner, Dennis R.; 94, 427, 557, 727, 908
Turner, Trevor Stanley; 1872, 1997
Tur'yan, Ya. I.; 609
Tuwiner, Sidney B.; 713, 1934
Tvarusko, Aladar; 1404, 1593
Tyco Labs; 3103, 3383
Tye, F.L.; 3054, 3297, 3378
Tyler, R.D.; 582
Tysyachnyi, V.P.; 3313

U

Uchiyama, Aiji A.; 582, 788, 1337, 1468, 2027, 3192
Udupa, H.V.K.; 2, 259, 318, 1059, 1682, 1683, 3264, 3276, 3304
Uflyand, N. Yu.; 1912, 2164, 3252, 3307
Ulam, Juliusz; 1375
Ul'Yanova, O.M.; 3285
Unger, John F.; 420, 1980
Uoupa, V.K.; 3188
Urry, Lewis F.; 598
Ushirokawa, A.; 3104

V

Vaccaro, F.J.; 1770
Van Dual, H.J.; 3328
Vander Grinten, Willem J.; 751, 879, 1141, 1176, 1226, 1381, 1764
Vander Hart, David; 410
Vander Lugt, L.A.; 411, 460, 485, 555, 2013
Vander Yacht, Clifford J.; 847
Van Ommering, G.; 1799, 3403
Van Tine, Bill; 1765
Vaughan, P.; 443
Vaughn, Joe W.; 1231
Vedder, W.; 3335
Veit, William B. 2170
Venkatakrihman, N.; 1689

Venkatesan, V.K.; 3188
Vergette, J.D.; 1412
Vernon, R.M.; 461
Vertes, M.A.; 538, 3395
Vetter, K. J.; 320
Vihayavalli, R.; 318
Viktorova, L.P.; 3282
Vincent, Colin A.; 1314
Visco, R.
Viswanathan, V.; 1012
Viyavalli, R.; 1682, 1683
Vogman, M.Sh.; 3130
Vogt, Hans E.; 638, 846, 853, 855
Vogt, J.W.; 763, 1449
Vol'Fkovich, Yu. M.; 3280
Voltz, Sterling E.; 11
Von Dohren, H.; 63
Von Hartmann, Werner; 1526, 1719
Voorhies, John D.; 1964
Voss, E.; 1345
Voyentzie, Peter R.; 39, 402, 466, 1333, 1379, 1629, 2106
Vozhova, N.A.; 280
Vriesenga, Jack; 410
Vulpio, William V.; 836

W

Wabner, D.W.; 3247
Wagner, Jr., J.B.; 1566
Wagner, Otto C.; 191, 199, 272, 297, 1334, 1339, 1424, 1509, 1827, 2057, 2099,
2103, 3125, 3126, 3162, 3375, 3384, 3392
Wagner, Regina D.; 517
Waite, John H.; 466, 637, 728, 801, 803, 921, 1225, 1249, 2132, 2133, 3090, 3237
Wakefield, B.; 3221
Walbrick, Johnny M.; 1693
Walfd, F.; 2012
Wales, Charles P.; 339, 349, 354, 400, 415, 521, 612, 752, 753, 1144, 1145,
1146, 1536, 1668, 1677, 1678, 1687
Walk, C.R.; 960, 1483
Walker, Robert D.; 3235, 3388
Walmsley, Donald E.; 1720
Walsh, T.; 1370
Waltz, Lee; 466
Wartell, J.; 89
Wasan, D.T.; 864, 1844
Watanabe, J.; 3224
Watanabe, Nobuatsu; 1763
Weaver, R.D.; 408, 738, 1035
Webb, Edmond F.; 171
Webb, James E.; 1929, 1986
Webster, Jr.; W.H.; 530, 558, 688, 1430, 1800, 2107, 3105
Webster, W.W.; 3372
Weeks, M.C.; 1769

Weinberger, Dan; 1281, 1337, 1468
Weininger, Joseph L.; 92, 287, 647, 903, 1493, 1596, 1711, 1902
Weinstock, Irwin B.; 440, 510, 635, 844, 1258, 1818
Wertheim, M.; 3029
West, G.D.; 1970, 3297, 3333
West, Hiry; 741
West, William S.; 1532
Wetherell, Thomas, J.; 563, 841
Wheeler, Norman D.; 10
Whiteburst, Claudia; 760, 3365
Wiers, Brandon; 343
Wijnen, Marinus Dirk; 2122
Wilstrom, L.; 2140
Wilburn, Nicholas T.; 480, 1213, 1641, 1815
Wilde, B.E.; 120
Wilfore, J.F.; 730, 1282
Wilke, Milton, E.; 847
Wilken, P.H.; 781, 831, 969, 1203, 1713
Will, Fritz G.; 1199, 1568, 1698, 1853, 2090, 3186
Williams, David L.; 995, 996, 997, 998, 999, 1217, 1262, 1291, 1847
Williams, Dorothy D.; 2177, 3162, 3375
Williams, B.C.; 382
Williams, N.J.; 1872
Williams, R.H.; 3220
Willihnganz, Eugene; 466, 1206, 2028, 2069
Willis, T.H.; 442, 727, 2020
Wilson, Arthur, M.; 1595
Wilson, H.D.; 15
Wilson, Jeff K.; 468, 645
Wilson, K.P.; 244
Wilson, L.; 912
Wilson, Louis; 11
Wilson, Raymond L.; 1337
Windler, Hans; 81
Winter, B.B.; 1173
Witte, J.; 288
Wojciak, Waclaw; 2162
Wolanski, Theordore J.; 1072
Wong, K. K-M.; 961, 1796
Wood, Donald B.; 1371, 1506, 2017
Woods, J.L.; 3106
Wootner, Leo; 3326
Work, G.W.; 250, 339
Worn, D.K.; 132
Wouk, V.; 1622, 1623
Wrangell, Lewis J.; 1984
Wright, W.H.; 1610
Wylie, Gayle M.; 313, 372, 842
Wylie, T.; 1646, 1833
Wynne-Jones, W.F.K.; 1273, 1274, 1275

Y

Yablokova, I.E.; 590
Yaffee, Michael L.; 111
Yamaga, M.; 3202
Yamamoto, S.; 3104, 3224
Yamamoto, Yoshihumi; 2183, 3263, 3268, 3300
Yamasaki, Masahiro; 1598, 1843
Yamashita, Daijiro; 905, 2183, 3158, 3163, 3248, 3263, 3268, 3301
Yamashita, O.; 1856
Yao, Neng, Ping; 1690, 1728, 2092, 3166
Yarnell, C.F.; 2073
Yashkov, M.P.; 3307
Yeager, Ernest B.; 2160, 3187, 3199
Yeager, V.; 206, 539
Yerman, A.J.; 1141, 1226, 1381
Yoa, N.P.; 111, 1181, 1248
Yoshizawa, Shiro; 179, 591, 629, 817, 1598, 1843, 1993, 3353, 3367, 3368, 3370
Yosim, Samuel J.; 1839
Yong, I.; 376
Youngquist, John A.; 1965
Yudina, T.F.; 1058
Yuen, Joseph; 2107
Yusukara, T.; 893

Z

Zaffrery, Efstratios D.; 658
Zaromb, S.; 259
Zavforodnyaya, E.F.; 3262
Zelman, D.A.; 1413, 1675, 1676, 1805
Zenin, G.S.; 3310
Zerbel, D.W.; 3099, 3100
Ziegler, Arthur W.; 1324
Zimina, K.S.; 3028
Zipkin, Morris A.; 29, 30
Zirin, Louis I.; 1072
Zubova, N.V.; 3307
Zucks, P.A.; 3107
Zurosky, Walter; 1039, 1046, 1157
Zwaagstra, R.L.; 1234, 1752
Zwick, Eugene B.; 1661, 3662